PATENT ABSTRACTS OF JAPAN

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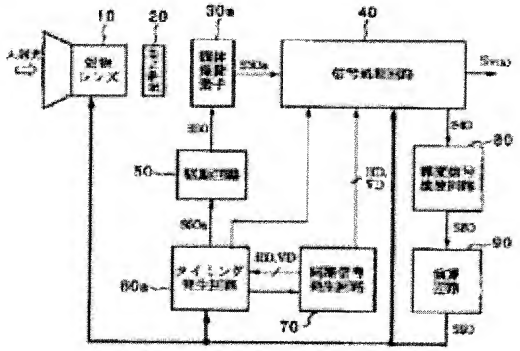
(71)Applicant : **SONY CORP**
(72)Inventor : **MORI HIROSHI**

(54) DEVICE AND METHOD FOR SOLID-STATE IMAGE PICKUP DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To realize a solid-state image-pickup device and the image-pickup method, by which a dynamic range is optimized depending on an image-pickup state by freely setting a sensitivity ratio for exposure periods divided into plural numbers, depending on an incident luminous quantity.

SOLUTION: A solid-state image-pickup element 30a divides an exposure period into plural numbers, generates an image signal S30a depending on charges stored for each period, a horizontal synchronization signal HD and a vertical synchronization signal VD generated by a synchronization signal which generates circuit 70 are fed to a timing generating circuit 60a and a signal processing circuit 40 to control the operating timing. A luminance signal detection circuit 80 detects a luminance signal S40 from the signal processing circuit 40 to provide an output of a detection signal S80, an arithmetic circuit 90 applies arithmetic processing to the detection signal S80 to discriminate the lightness of an image, the contrast and the reverse light state, produces a control signal S90 and is fed back to an objective lens, the timing generating circuit 60a, and the signal processing circuit 40 for conducting exposure control.



CLAIMS

[Claim(s)]
[Claim 1]An electric charge accumulated in a photo detector according to incident light quantity from an image pick-up subject during an electric charge storage period is transmitted via transfer elements, A solid state camera which has a control means which controls time length of at least one period among periods which it is a solid state camera outputted as a picture signal, divided the above-mentioned electric charge storage period at least in two periods, the 1st period and the 2nd period, and divided [above-mentioned] according to the above-mentioned incident light quantity.
[Claim 2]The solid state camera according to claim 1 which controls time length of at least one period among periods which have a detection means which detects a described image signal, and the above-mentioned control means divided [above-mentioned] according to an output signal of the detection means concerned.
[Claim 3]Transmit an electric charge accumulated in the above-mentioned photo detector to the above-mentioned holding mechanism, and it is made to hold to electric charge holding mechanism holding an electric charge accumulated in the above-mentioned photo detector, and the 1st timing after the above-mentioned end of the 1st period, The solid state camera according to claim 1 which has a transfer control means which transmits an electric charge currently held to the 2nd timing at the above-mentioned electric charge holding mechanism to the above-mentioned transfer elements, transmits an electric charge accumulated in the above-mentioned photo detector to the 3rd timing after the above-mentioned end of the 2nd period throughout [2nd above-mentioned term] to the above-mentioned transfer elements, and is made to output.
[Claim 4]A light sensing portion which consists of two or more photo detectors which were provided for every pixel and have been arranged at matrix form, A vertical transfer part which consists of transfer elements which transmit an electric charge which it stood in a row in a column direction, has been arranged for every light receiving element line of the above-mentioned light sensing portion, and was accumulated in the above-mentioned photo detector according to incident light quantity from an image pick-up subject during an electric charge storage period to a column direction, An electric charge sent from transfer elements of the above-mentioned vertical transfer part is transmitted to a line writing direction, A horizontal transfer part which consists of transfer elements outputted as a picture signal of a time series, and a detection means which detects a picture signal outputted by the above-mentioned horizontal transfer part, An exposure-time-control means to control time length of at least one period among periods which divided the above-mentioned electric charge storage period at least in two periods, the 1st period and the 2nd period, and divided [above-mentioned] according to an output signal of the above-mentioned detection means, Transmit an electric charge accumulated in a photo detector of the above-mentioned light sensing portion throughout [1st concerned term] to the above-mentioned electric charge holding mechanism, and it is made to hold to electric charge holding mechanism holding an electric charge accumulated in the above-mentioned photo detector, and the 1st timing after the above-mentioned end of the 1st period, An electric charge currently held to the 2nd timing at the above-mentioned electric charge

holding mechanism is transmitted to transfer elements of the above-mentioned vertical transfer part, A solid state camera which has a transfer control means which transmits an electric charge accumulated in a photo detector of the above-mentioned light sensing portion to the 3rd timing after the above-mentioned end of the 2nd period throughout [2nd concerned term] to transfer elements of the above-mentioned vertical transfer part.
[Claim 5]The solid state camera according to claim 4 with which the 2nd timing of the above is set as the above-mentioned vertical transfer part after an end of transmission of stored charge according to a picture signal of the front field.
[Claim 6]The solid state camera according to claim 4 which an electric charge of each photo detector is cleared and the next electric charge storage period starts after an electric charge accumulated in a photo detector of the above-mentioned light sensing portion to the 1st timing of the above transmits to the above-mentioned electric charge holding mechanism.
[Claim 7]A light sensing portion which consists of two or more photo detectors which were provided for every pixel and have been arranged at matrix form, A vertical transfer part which consists of transfer elements which transmit an electric charge which it stood in a row in a column direction, has been arranged for every light receiving element line of the above-mentioned light sensing portion, and was accumulated in the above-mentioned photo detector according to incident light quantity from an image pick-up subject during an electric charge storage period to a column direction, An electric charge sent from transfer elements of the above-mentioned vertical transfer part is transmitted to a line writing direction, A horizontal transfer part which consists of transfer elements outputted as a picture signal of a time series, and a detection means which detects a picture signal outputted by the above-mentioned horizontal transfer part, An exposure-time-control means to control time length of at least one period among periods which divided the above-mentioned electric charge storage period at least in two periods, the 1st period and the 2nd period, and divided [above-mentioned] according to an output signal of the above-mentioned detection means, Transmit an electric charge accumulated in a photo detector of the above-mentioned light sensing portion throughout [1st concerned term] to the above-mentioned electric charge holding mechanism, and it is made to hold to electric charge holding mechanism holding an electric charge accumulated in the above-mentioned photo detector, and the 1st timing after the above-mentioned end of the 1st period, Inside of an electric charge which transmits an electric charge accumulated with a photo detector of odd lines among electric charges currently held to the 2nd timing at the above-mentioned electric charge holding mechanism to transfer elements of the above-mentioned vertical transfer part, and is held to the 3rd timing at the above-mentioned electric charge holding mechanism, An electric charge accumulated with a photo detector of even lines is transmitted to transfer elements of the above-mentioned vertical transfer part, An electric charge accumulated in a photo detector of odd lines of the above-mentioned light sensing portion to the 4th timing after the above-mentioned end of the 2nd period throughout [2nd concerned term] is transmitted to transfer elements of the above-mentioned vertical transfer part, A solid state camera which has a transfer control means which transmits an electric charge accumulated in a photo detector of even lines of the above-mentioned light sensing portion to the 5th timing throughout [2nd above-mentioned term] to transfer elements of the above-mentioned vertical transfer part.
[Claim 8]The solid state camera according to claim 7 constituted by charge holding element which stores an electric charge which the above-mentioned electric charge holding mechanism was established for every photo detector of the above-mentioned light sensing portion, and has been sent from each photo detector of the above-mentioned light sensing portion to the 1st timing of the above.
[Claim 9]The solid state camera according to claim 7 which an electric charge of each photo detector is cleared and the next electric charge storage period starts after an electric charge accumulated in a photo detector of the above-mentioned light sensing portion to the 1st timing of the above transmits to the above-mentioned electric charge holding mechanism.
[Claim 10]The solid state camera according to claim 7 with which 1 time of transfer operation is performed in the above-mentioned vertical transfer part after stored charge of a photo detector

of odd lines currently held to the 2nd timing of the above at the above-mentioned electric charge holding mechanism transmits to transfer elements of the above-mentioned vertical transfer part.
[Claim 11]The solid state camera according to claim 10 with which stored charge of the odd-line photo detector currently held at each transfer elements of the above-mentioned vertical transfer part is mixed with stored charge of a photo detector of even lines sent from the above-mentioned electric charge holding mechanism to the 3rd timing of the above after the above-mentioned transfer operation is performed.
[Claim 12]The solid state camera according to claim 7 with which 1 time of transfer operation is performed in the above-mentioned vertical transfer part after stored charge of a photo detector of the odd above-mentioned lines transmits to transfer elements of the above-mentioned vertical transfer part to the 4th timing of the above.
[Claim 13]The solid state camera according to claim 12 with which stored charge of the odd-line photo detector currently held at each transfer elements of the above-mentioned vertical transfer part is mixed with stored charge sent from a photo detector of the even above-mentioned lines to the 5th timing of the above after the above-mentioned transfer operation is performed.
[Claim 14]According to incident light quantity from an image pick-up subject, an electric charge is accumulated in a photo detector during an electric charge storage period, It is an imaging method of a solid state camera which transmits an accumulated electric charge via transfer elements, and is outputted as a picture signal, An imaging method of a solid state camera which controls time length of at least one period among periods which divided the above-mentioned electric charge storage period at least in two periods, the 1st period and the 2nd period, and divided [above-mentioned] according to the above-mentioned incident light quantity.
[Claim 15]Two or more photo detectors arranged at matrix form accumulate an electric charge according to incident light quantity from an image pick-up subject during an electric charge storage period, An accumulated electric charge is transmitted to a sequence method of the above-mentioned matrix by a vertical transfer element arranged for every sequence of the above-mentioned photo detector, An electric charge sent by the above-mentioned vertical transfer element is transmitted to a line writing direction of the above-mentioned matrix by a horizontal transfer element, It is an imaging method of a solid state camera outputted as a picture signal of a time series, The above-mentioned electric charge storage period is divided at least in two periods, the 1st period and the 2nd period, Time length of at least one period is controlled among periods which divided [above-mentioned] according to a described image signal, An electric charge accumulated in the above-mentioned photo detector to the 1st timing after the above-mentioned end of the 1st period is held, An imaging method of a solid state camera which transmits an electric charge held [above-mentioned] to the 2nd timing to the above-mentioned vertical transfer element, and transmits an electric charge accumulated in the above-mentioned photo detector to the 3rd timing after the above-mentioned end of the 2nd period to the above-mentioned vertical transfer element.
[Claim 16]An imaging method of the solid state camera according to claim 15 which clears an electric charge of the above-mentioned photo detector, and starts the next electric charge storage period after transmitting an electric charge accumulated in the above-mentioned photo detector to the 1st timing of the above to the above-mentioned electric charge holding mechanism.
[Claim 17]An imaging method of the solid state camera according to claim 15 with which the 2nd timing of the above is set as the above-mentioned vertical transfer element after an end of transmission of stored charge according to a picture of the front field.
[Claim 18]Two or more photo detectors arranged at matrix form accumulate an electric charge according to incident light quantity from an image pick-up subject during an electric charge storage period, An accumulated electric charge is transmitted to a sequence method of the above-mentioned matrix by a vertical transfer element arranged for every sequence of the above-mentioned photo detector, An electric charge sent by the above-mentioned vertical transfer element is transmitted to a line writing direction of the above-mentioned matrix by a

horizontal transfer element, It is an imaging method of a solid state camera outputted as a picture signal of a time series, The above-mentioned electric charge storage period is divided at least in two periods, the 1st period and the 2nd period, Time length of at least one period is controlled among periods which divided [above-mentioned] according to a described image signal, An electric charge accumulated in the above-mentioned photo detector to the 1st timing after the above-mentioned end of the 1st period is held, An electric charge accumulated with a photo detector of odd lines among electric charges held [above-mentioned] to the 2nd timing is transmitted to the above-mentioned vertical transfer element, An electric charge accumulated with a photo detector of even lines among electric charges held [above-mentioned] to the 3rd timing is transmitted to the above-mentioned vertical transfer element, An imaging method of a solid state camera which transmits an electric charge accumulated in a photo detector of odd lines to the 4th timing after the above-mentioned end of the 2nd period to the above-mentioned vertical transfer element, and transmits an electric charge accumulated in a photo detector of even lines to the 5th timing to the above-mentioned vertical transfer element.

[Claim 19]An imaging method of the solid state camera according to claim 18 which clears an electric charge of the above-mentioned photo detector, and starts the next electric charge storage period after transmitting an electric charge accumulated in the above-mentioned photo detector to the 1st timing of the above to the above-mentioned electric charge holding mechanism.

[Claim 20]An imaging method of the solid state camera according to claim 18 with which the 2nd timing of the above is set as the above-mentioned vertical transfer element after an end of transmission of stored charge according to a picture of the front field.

[Claim 21]An imaging method of the solid state camera according to claim 18 mixed with an electric charge to which the above-mentioned vertical transfer element performed 1 time of transfer operation after transfer operation in the 2nd timing of the above, and an electric charge of after-transmission each transfer elements has been sent to the 3rd timing of the above.

[Claim 22]An imaging method of the solid state camera according to claim 18 mixed with an electric charge to which the above-mentioned vertical transfer element performed 1 time of transfer operation after the 4th transfer operation of the above, and an electric charge of each transfer elements after transmission has been sent to the 5th timing of the above.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The exposure time in at least one period is controlled by this invention among two or more periods which divided the solid state camera, for example, an electric charge storage period, in two or more periods, and were divided according to the contrast of incident light quantity and a picture, etc.
Therefore, the incident-light-quantity-sensitivity characteristic of each period is controlled, and it is hard to be saturated to incident light quantity, and is related with a solid state camera which can do a dynamic range widely, and an imaging method for the same.

[0002]
[Description of the Prior Art]In the solid state camera using CCD (Charge Coupled Device: charge coupled devices) etc., The signal charge which accumulated the electric charge according to the incident light from an image pick-up subject, and was accumulated by transfer elements etc. is changed into the electrical signal of a time series using photo detectors, such as a photo-diode, and it outputs as a picture signal.
[0003]Drawing 7 is a block diagram showing the example of 1 composition of the conventional solid state camera. The solid state camera of this example is constituted by the object lens 10, the light filter 20, the solid state image pickup device 30, the digital disposal circuit 40, the drive circuit 50, the timing generating circuit 60, the synchronizing signal generation circuit 70, the luminance-signal detector circuit 80, and the arithmetic circuit 90 like a graphic display.
[0004]Horizontal Synchronizing signal HD and Vertical Synchronizing signal VD are generated by the synchronizing signal generation circuit 70, respectively. The timing generating circuit 60 operates synchronizing with Horizontal Synchronizing signal HD and Vertical Synchronizing signal VD from the synchronizing signal generation circuit 70, and generates the driving pulse signal S60 which controls the operation timing of the whole solid state camera. The drive circuit 50 carries out current / amplitude amplification, and inputs the driving pulse signal S60 from the timing generating circuit 60 into the solid state image pickup device 30.
[0005]The incident light from an image pick-up subject is irradiated by the solid state image pickup device 30 via the object lens 10 and the light filter 20. The solid state image pickup device 30 is the timing set up with the driving pulse signal S50 amplified by the drive circuit 50, generates the picture signal S30 which is an electrical signal according to incident light quantity, and outputs it to the digital disposal circuit 40. The digital disposal circuit 40 is outputted as video signal S_{VDO}, after processing the picture signal from the solid state image pickup device 30 and adding Horizontal Synchronizing signal HD and Vertical Synchronizing signal VD from the synchronizing signal generation circuit 70 to it.
[0006]In response to the video signal (only henceforth a luminance signal) S40 which includes the luminance-signal information in the middle of processing in the digital disposal circuit 40, the luminance-signal detector circuit 80 detects it, and outputs the detection signal S80. The arithmetic circuit 90 performs the judgment of the luminosity of a picture, contrast, or a backlight state based on it in response to the detection signal S80 from the luminance-signal

detector circuit 80. According to a decision result, the control signal S90 which performs setting out of shutter speed or AGC is generated, the object lens 10, the timing generating circuit 60, and the digital disposal circuit 40 are supplied, respectively, and this feedback performs exposure control.

[0007]Drawing 8 is a plot plan showing the structure of the solid state image pickup device 30 used for the conventional solid state camera. The plurality by which the solid state image pickup device 30 has been arranged like a graphic display at matrix form, For example (), [mxn and] m and n are positive integers -- photo detector $PD_{1 \text{ of an individual, } 1}$, $PD_{1, 2}$, --, $PD_{1, n}$, $PD_{2, 1}$, $PD_{2, 2}$, --, $PD_{3, 1}$, $PD_{3, 2}$, --, $PD_{m, 1}$, $PD_{m, 2}$, --, the light sensing portion constituted by $PD_{m \text{ and } n}$. Stand in a row in the column direction of a light sensing portion, and it is provided in the termination of the vertical transfer part 32 which consists of transfer elements provided for every sequence of a photo detector, the horizontal transfer part 34 which consists of transfer elements which transmit the electric charge sent from the vertical transfer part to a line writing direction, and a horizontal transfer part, It is constituted by the electric charge detection amplifier 36 which detects the existence of an electric charge, and the output amplifier 38 which outputs the signal from the electric charge detection amplifier 36. The vertical transfer part 32 is constituted by transfer-elements 32_{-1} of n sequence arranged in the column direction of the matrix, 32_{-2}, --, 32_{-n}, for example according to the sequence of the photo detector arranged at matrix form.

[0008]Namely, the solid state image pickup device 30 is a solid state image pickup device of the general Inta line system, and is premised on the field read operation which mixes the signal charge of the photo detector which adjoined perpendicularly inside the vertical transfer element of a vertical transfer part.

[0009]Photo detector $PD_{1, 1}$, $PD_{1, 2}$, --, $PD_{1, n}$, $PD_{2, 1}$, $PD_{2, 2}$, --, $PD_{3, 1}$, $PD_{3, 2}$, --, $PD_{m, 1}$, $PD_{m, 2}$, --, $PD_{m, \text{ and } n}$, For example, it is constituted by photosensors, such as a photo-diode which accumulates the electric charge of the specified quantity according to the light volume which entered during exposure time (electric charge storage period), and the vertical transfer element and the horizontal transfer element are constituted by the register, for example. The output signal from the output amplifier 38 is the picture signal S30 generated with the solid state image pickup device 30.

[0010]Drawing 9 is a key map showing operation of charge transfer and mixing. [in / in the wave form chart and drawing 10 in which the operation timing of the solid state image pickup device 30 is shown / the solid state image pickup device 30] Hereafter, the charge storage in the solid state image pickup device 30, transmission, and mixed operation of this example are explained, referring to these Drawings. As shown in drawing 9, the electric charge accumulated in each photo detector of the light sensing portion at the exposure time A is read to the transfer elements (only henceforth a vertical transfer register) of a vertical transfer part in the timing of time T_{RO1}. It becomes possible only after entering at the vertical blanking period after the charge transfer in a vertical transfer register is completed, and this operation cannot be performed other than vertical blanking. The photo detector which became immediately after this read-out in the sky starts the accumulation operation of the following 1 field.

[0011]After the signal charge accumulated with the photo detector of odd lines among the signal charges accumulated in the same exposure time A and the signal charge accumulated with the photo detector of even lines were mixed within the vertical transfer register, It is transmitted to the electric charge detection amplifier 36 at a time series, the result of electric charge detection is amplified by vertical transfer, the transmission between vertical register horizontal registers, and horizontal transfer with the output amplifier 38, and the signal charge accumulated in the exposure time A and the exposure time B, respectively is outputted as the picture signal S30.

[0012]

[Problem(s) to be Solved by the Invention]By the way, in the conventional solid state camera mentioned above, the storage period of each ****** which constitutes the picture of the 1 field

is only one period per each field, and the sensitivity characteristic over the amount of input light serves as a temporary straight line, as shown in drawing 11. In this case, if the amount of input light becomes to some extent large, the output of a photo detector will be saturated and the high-intensity portion of a picture will be crushed. In order to avoid the saturation of a picture, there is usage which suppresses the sensitivity characteristic over light volume using exposure control functions, such as an electronic shutter, but the sensitivity in a portion dark on the contrary runs short, and it becomes impossible to obtain sufficient output level. That is, when the difference of the luminance level in 1 screen picturizes a large photographic subject, there is a disadvantage that enough dynamic ranges cannot be obtained.
[0013]In [as shown in drawing 7, in the luminance-signal detector circuit 80, processing of integration treatment peak detection, etc. is performed to the luminance signal S40 from the digital disposal circuit 40 and] the arithmetic circuit 90 the detection signal S80 from the luminance-signal detector circuit 80, The luminosity of a picture, the judgment of contrast and a backlight state, etc. are performed. Although speed control of an electronic shutter, mechanism iris control of the object lens 10, or gain control of AGC is automatically performed to the image state judged in the arithmetic circuit 90, Since exposure setting out which can choose the conventional solid state camera is a general way, when the difference of the luminance level in 1 screen picturizes a large photographic subject, the problem that enough dynamic ranges cannot be obtained remains.
[0014]this invention is made in view of this situation, and comes out. The purpose is to set up arbitrarily the sensitivity ratio of the exposure time divided into plurality according to the decision result of **, and according to incident light quantity, a sensitivity characteristic can be set up freely, and it is in providing a solid state camera which can optimize a dynamic range according to an image pick-up state, and an imaging method for the same.

[0015]
[Means for Solving the Problem]In order to attain the above-mentioned purpose, a solid state camera of this invention, An electric charge accumulated in a photo detector according to incident light quantity from an image pick-up subject during an electric charge storage period is transmitted via transfer elements during a transmission period, It is a solid state camera outputted outside as a picture signal, and the above-mentioned electric charge storage period is divided at least in two periods, the 1st period and the 2nd period, and it has a control means which controls time length of at least one period among periods which divided [above-mentioned] according to the above-mentioned incident light quantity.
[0016]It has a detection means which detects a described image signal suitably, and the above-mentioned control means controls time length of at least one period by this invention among periods which divided [above-mentioned] according to an output signal of the detection means concerned. A solid state camera of this invention is provided with the following.
Electric charge holding mechanism holding an electric charge accumulated in the above-mentioned photo detector.
Transmit an electric charge accumulated in the above-mentioned photo detector to the above-mentioned holding mechanism, and it is made to hold to the 1st timing after the above-mentioned end of the 1st period, A transfer control means which transmits an electric charge currently held to the 2nd timing at the above-mentioned electric charge holding mechanism to the above-mentioned transfer elements, transmits an electric charge accumulated in the above-mentioned photo detector to the 3rd timing after the above-mentioned end of the 2nd period throughout [2nd above-mentioned term] to the above-mentioned transfer elements, and is made to output.

[0017]A solid state camera of this invention is provided with the following.
A light sensing portion which consists of two or more photo detectors which were provided for every pixel and have been arranged at matrix form.
A vertical transfer part which consists of transfer elements which transmit an electric charge which it stood in a row in a column direction, has been arranged for every light receiving element

line of the above-mentioned light sensing portion, and was accumulated in the above-mentioned photo detector according to incident light quantity from an image pick-up subject during an electric charge storage period to a column direction.
A horizontal transfer part which consists of transfer elements which transmit an electric charge sent from transfer elements of the above-mentioned vertical transfer part to a line writing direction, and are outputted as a picture signal of a time series.
A detection means which detects a picture signal outputted by the above-mentioned horizontal transfer part, and the above-mentioned electric charge storage period are divided at least in two periods, the 1st period and the 2nd period, An exposure-time-control means to control exposure time of at least one period among periods which divided [above-mentioned] according to an output signal of the above-mentioned detection means, Transmit an electric charge accumulated in a photo detector of the above-mentioned light sensing portion throughout [1st concerned term] to the above-mentioned electric charge holding mechanism, and it is made to hold to electric charge holding mechanism holding an electric charge accumulated in the above-mentioned photo detector, and the 1st timing after the above-mentioned end of the 1st period, A transfer control means which transmits an electric charge currently held to the 2nd timing at the above-mentioned electric charge holding mechanism to transfer elements of the above-mentioned vertical transfer part, and transmits an electric charge accumulated in a photo detector of the above-mentioned light sensing portion to the 3rd timing after the above-mentioned end of the 2nd period throughout [2nd concerned term] to transfer elements of the above-mentioned vertical transfer part.

[0018]A solid state camera of this invention is provided with the following.
A light sensing portion which consists of two or more photo detectors which were provided for every pixel and have been arranged at matrix form.
A vertical transfer part which consists of transfer elements which transmit an electric charge which it stood in a row in a column direction, has been arranged for every light receiving element line of the above-mentioned light sensing portion, and was accumulated in the above-mentioned photo detector according to incident light quantity from an image pick-up subject during an electric charge storage period to a column direction.
A horizontal transfer part which consists of transfer elements which transmit an electric charge sent from transfer elements of the above-mentioned vertical transfer part to a line writing direction, and are outputted as a picture signal of a time series.
A detection means which detects a picture signal outputted by the above-mentioned horizontal transfer part, and the above-mentioned electric charge storage period are divided at least in two periods, the 1st period and the 2nd period, An exposure-time-control means to control exposure time of at least one period among periods which divided [above-mentioned] according to an output signal of the above-mentioned detection means, Transmit an electric charge accumulated in a photo detector of the above-mentioned light sensing portion throughout [1st concerned term] to the above-mentioned electric charge holding mechanism, and it is made to hold to electric charge holding mechanism holding an electric charge accumulated in the above-mentioned photo detector, and the 1st timing after the above-mentioned end of the 1st period, An electric charge accumulated with a photo detector of odd lines among electric charges currently held to the 2nd timing at the above-mentioned electric charge holding mechanism is transmitted to transfer elements of the above-mentioned vertical transfer part, An electric charge accumulated with a photo detector of even lines among electric charges currently held to the 3rd timing at the above-mentioned electric charge holding mechanism is transmitted to transfer elements of the above-mentioned vertical transfer part, An electric charge accumulated in a photo detector of odd lines of the above-mentioned light sensing portion to the 4th timing after the above-mentioned end of the 2nd period throughout [2nd concerned term] is transmitted to transfer elements of the above-mentioned vertical transfer part, A transfer control means which transmits an electric charge accumulated in a photo detector of even lines of the above-mentioned light sensing portion to the 5th timing throughout [2nd above-mentioned term] to transfer elements of the above-mentioned vertical transfer part.

[0019]During an electric charge storage period, an imaging method of a solid state camera of this invention transmits an electric charge which accumulated and accumulated an electric charge in a photo detector according to incident light quantity from an image pick-up subject via transfer elements, and outputs it as a picture signal. The above-mentioned electric charge storage period is divided at least in two periods, the 1st period and the 2nd period, and time length of at least one period is controlled among periods which divided [above-mentioned] according to the above-mentioned incident light quantity.
[0020]An imaging method of a solid state camera of this invention, Two or more photo detectors arranged at matrix form accumulate an electric charge according to incident light quantity from an image pick-up subject during an electric charge storage period, An accumulated electric charge is transmitted to a sequence method of the above-mentioned matrix by a vertical transfer element arranged for every sequence of the above-mentioned photo detector, An electric charge sent by the above-mentioned vertical transfer element is transmitted to a line writing direction of the above-mentioned matrix by a horizontal transfer element, It is an imaging method of a solid state camera outputted as a picture signal of a time series, The above-mentioned electric charge storage period is divided at least in two periods, the 1st period and the 2nd period, Time length of at least one period is controlled among periods which divided [above-mentioned] according to a described image signal, An electric charge accumulated in the above-mentioned photo detector to the 1st timing after the above-mentioned end of the 1st period is held, An electric charge accumulated with a photo detector of odd lines among electric charges held [above-mentioned] to the 2nd timing is transmitted to the above-mentioned vertical transfer element, An electric charge accumulated with a photo detector of even lines among electric charges held [above-mentioned] to the 3rd timing is transmitted to the above-mentioned vertical transfer element, An electric charge accumulated in a photo detector of odd lines to the 4th timing after the above-mentioned end of the 2nd period is transmitted to the above-mentioned vertical transfer element, and an electric charge accumulated in a photo detector of even lines to the 5th timing is transmitted to the above-mentioned vertical transfer element.
[0021]Since exposure time of at least one period is controlled among two or more periods which an image pick-up period of a solid state camera was divided at plurality, for example, at least two periods, and were divided according to incident light quantity according to this invention, A sensitivity ratio of exposure time divided into plurality according to incident light quantity from a photographic subject and image pick-up conditions, the image pick-up purpose, etc. can set up arbitrarily, and optimization of a dynamic range of a solid state camera can be realized.
[0022]A light sensing portion which consists of a photo detector which was provided for every pixel and has been arranged concretely at matrix form, for example, A vertical transfer register which transmits and mixes perpendicularly a signal charge accumulated in a photo detector during exposure time, To a solid state image pickup device which consists of a horizontal transfer register transmitted horizontally, a signal charge sent from a vertical transfer register. By adding a detection means which detects a luminance signal of a picture signal outputted from a horizontal transfer register, and controlling exposure time in at least one period among two or more periods divided according to detection results of a detection means, A sensitivity ratio of each exposure time can be set up and a dynamic range of a solid state camera can be optimized.

[0023]In order to set up freely exposure time of two or more divided periods, a charge holding element which holds stored charge of each photo detector for every photo detector of each light sensing portion temporarily is provided in a solid state image pickup device. For example, as an example, when charge storage time divides into two, the 1st period and the 2nd period, all signal charges accumulated in each photo detector to the 1st timing after the end of the 1st period are transmitted to a charge holding element. And in the 2nd timing and 3rd timing after vertical transfer of the 1 field in a vertical transfer register is completed, a maintenance electric charge of odd lines and even lines in a charge holding element is transmitted to a vertical transfer register one by one, and is mixed in a vertical transfer register. In the 4th and 5th timing after

the end of the 2nd period, a signal charge accumulated in a photo detector of odd lines and even lines is transmitted to a vertical transfer register one by one, After being mixed in a vertical transfer register, it is transmitted to a horizontal register and is further outputted as a picture signal of a time series with a horizontal transfer register. Exposure time of two or more periods divided in this way can set up arbitrarily, the incident-light-quantity-sensitivity characteristic of a solid state image pickup device can be set up arbitrarily, and optimization of a dynamic range can be realized.

[0024]

[Embodiment of the Invention]Drawing 1 is a circuit diagram showing one embodiment of the solid state camera concerning this invention. The solid state camera of this example is constituted by the object lens 10, the light filter 20, the solid state image pickup device 30a, the digital disposal circuit 40, the drive circuit 50, the timing generating circuit 60a, the synchronizing signal generation circuit 70, the luminance-signal detector circuit 80, and the arithmetic circuit 90 like like a graphic display.

[0025]If the solid state camera of this embodiment removes the solid state image pickup device 30a and the timing generating circuit 60a compared with the conventional solid state camera shown in drawing 7, other component part is constituted by the almost same circuit. However, by having devised the composition and operation timing of the solid state image pickup device 30a in this invention, The exposure time in at least one period can be arbitrarily set up among two or more periods divided from the electric charge storage period, The sensitivity characteristic of each exposure time in a solid state camera could be set up freely by this, degradation of the light volume-sensitivity characteristic in a high luminance region could be avoided, and optimization of the dynamic range was realized. In order to control the solid state image pickup device 30a operation timing to which improvement was performed, a change according to it of the timing generating circuit 60a is made.

[0026]In the solid state camera shown in drawing 1, Horizontal Synchronizing signal HD and Vertical Synchronizing signal VD are generated by the synchronizing signal generation circuit 70, respectively. The timing generating circuit 60a operates synchronizing with Horizontal Synchronizing signal HD and Vertical Synchronizing signal VD from the synchronizing signal generation circuit 70, and generates the driving pulse signal S60a which controls the operation timing of the whole solid state camera. The drive circuit 50 carries out current / amplitude amplification, and inputs the driving pulse signal S60a from the timing generating circuit 60 into the solid state image pickup device 30a.

[0027]The incident light from an image pick-up subject is irradiated by the solid state image pickup device 30a via the object lens 10 and the light filter 20. The solid state image pickup device 30a is the timing set up with the driving pulse signal S50 amplified by the drive circuit 50, generates the picture signal S30a according to incident light quantity, and outputs it to the digital disposal circuit 40. The digital disposal circuit 40 is outputted as video signal S_{VDO}, after processing the picture signal from the solid state image pickup device 30 and adding Horizontal Synchronizing signal HD and Vertical Synchronizing signal VD from the synchronizing signal generation circuit 70 to it.

[0028]The luminance-signal detector circuit 80 detects it in response to the luminance signal S40 in the middle of processing in the digital disposal circuit 40, and outputs the detection signal S80. The arithmetic circuit 90 performs the judgment of the luminosity of a picture, contrast, or a backlight state based on it in response to the detection signal S80 from the luminance-signal detector circuit 80. According to a decision result, the control signal S90 which performs shutter speed control, mechanism iris control of an object lens, or gain control of AGC is generated, the object lens 10, the timing generating circuit 60a, and the digital disposal circuit 40 are supplied, respectively, and this feedback performs exposure control.

[0029]Drawing 2 is a plot plan showing the internal configuration of the solid state image pickup device 30a in this embodiment. The plurality by which the solid state image pickup device 30a has been arranged like a graphic display at matrix form, For example, it has photo detector PD_{1} of an individual (mxn), 1, $PD_{1,2}$, --, $PD_{1,n}$, $PD_{2,1}$, $PD_{2,2}$, --, $PD_{3,1}$, $PD_{3,2}$, --, $PD_{m,1}$, $PD_{m,2}$--, and

the light sensing portion constituted by $PD_{m\ and\ n}$, Furthermore, charge holding element $CR_{1,1}$, $CR_{1,2}$, --, $CR_{1,n}$, $CR_{2,1}$, $CR_{2,2}$, --, $CR_{3,1}$, $CR_{3,2}$, --, $CR_{m,1}$, $CR_{m,2}$, --, $CR_{m,\ and\ n}$ are provided in a light sensing portion for every photo detector, The electric charge retaining function holding the stored charge of each photo detector was added to the solid state camera of this embodiment by this. It stands in a row in the column direction of a light sensing portion like the conventional solid state camera shown in drawing 7, It is provided in the termination of the vertical transfer part 32 which consists of transfer elements provided for every sequence of a photo detector, the horizontal transfer part 34 which consists of transfer elements which transmit the electric charge sent from the vertical transfer part to a line writing direction, and a horizontal transfer part, The electric charge detection amplifier 36 which detects the existence of an electric charge, and the output amplifier 38 which outputs the signal from the electric charge detection amplifier 36 are formed, respectively.

[0030]Photo detector $PD_{1,1}$, $PD_{1,2}$, $PD_{1,3}$, --, $PD_{1,n}$, $PD_{2,1}$, --, $PD_{3,1}$, --, $PD_{m,1}$--, $PD_{m,\ and\ n}$, For example, it is constituted by photosensors, such as a photo-diode which accumulates the electric charge of the specified quantity according to the light volume which entered during exposure time. Charge holding element $CR_{1,1}$, $CR_{1,2}$, --, $CR_{1,n}$, $CR_{2,1}$, $CR_{2,2}$, --, $CR_{3,1}$, $CR_{3,2}$, --, $CR_{m,1}$, $CR_{m,2}$, --, $CR_{m,\ and\ n}$, It consists of a charge holding element held temporarily, and a register or a capacitor can constitute the electric charge accumulated in the photo detector as the example, for example.

[0031]The vertical transfer part 32 is constituted by transfer-elements 32_{-1} of n sequence arranged in the column direction of the matrix, 32_{-2}, --, 32_{-n}, for example according to the sequence of the photo detector arranged at matrix form, and transfer elements are constituted by the register, for example. The horizontal transfer part 34 consists of a horizontal transfer element which transmits the electric charge sent from the vertical transfer part horizontally (line writing direction of the matrix which a photo detector makes). The horizontal transfer element is constituted by the register like the vertical transfer element, for example.

[0032]The wave form chart and drawing 4 which drawing 3 shows the operation timing of the solid state image pickup device 30a of this embodiment are a key map showing operation of the charge storage in the solid state image pickup device 30a, and charge transfer. Hereafter, the charge storage and transfer operation of a solid state camera of this embodiment are explained, referring to these Drawings. As shown in drawing 3, the electric charge storage period in the solid state image pickup device 30a of this embodiment is divided at the two periods A1, i.e., exposure time, and the exposure time B1. The exposure time A1 and the exposure time B1 are arbitrarily distributed between the normal operation period and the vertical blanking period. Among the exposure time A1 and the exposure time B1, at least one exposure time A1, for example, exposure time, can set up according to the control signal S90 from the arithmetic circuit 90 shown in drawing 1, and by this, The incident-light-quantity-sensitivity characteristic of each divided exposure time can set up arbitrarily, and the sensitivity ratio during each exposure time can set up freely.

[0033]Hereafter, operation of the solid state image pickup device 30a is explained in order of exposure time A1 and B1. The electric charge accumulated in each photo detector at the exposure time A1 in the timing of time T_{RO1} Each photo detector $PD_{1,1}$, $PD_{1,2}$, --, $PD_{1,n}$, $PD_{2,1}$, $PD_{2,2}$, --, $PD_{3,1}$, $PD_{3,2}$, --, $PD_{m,1}$, $PD_{m,2}$--, Charge holding element $CR_{1\ provided\ according\ to\ each\ photo\ detector\ from\ PD_{m\ and\ n}}$, $CR_{1,2}$, --, $CR_{1,n}$, $CR_{2,1}$, $CR_{2,2}$, --, $CR_{3,1}$, $CR_{3,2}$, --, $CR_{m,1}$, $CR_{m,2}$, --, $CR_{m,\ It\ is\ read\ to\ n}$. Since this read operation does not affect the signal charge in a vertical transfer register, it is not concerned with whether vertical transfer was completed, but it can be carried out to arbitrary timing. The photo detector which became immediately after this read-out in the sky starts the next accumulation operation.

[0034]Photo detector $PD_{1\ [\ in\ /\ in\ drawing\ 4\ /\ the\ solid\ state\ image\ pickup\ device\ 30a\ ],\ i}$, $PD_{2,i}$, --, $PD_{m,}$

the photo detector of the party who consists of i. The charge storage and transfer operation of charge holding element $CR_{1,i}$, $CR_{2,i}$, —, charge holding element [of the party who consists of $CR_{m \text{ and } i}$], and vertical transfer register 30_{-i} are illustrated. The figure (a) shows as an example photo detector $PD_{1,i}$, $PD_{2,i}$, —, charge holding element $CR_{1 \text{ from } PD_{m \text{ and } i},i}$, $CR_{2,i}$, —, signs that a signal charge is transmitted to $CR_{m \text{ and } i}$.

[0035]Next, after the vertical transfer of the signal charge of a previous field is completed, the signal charge accumulated in the exposure time A1 with the photo detector of odd lines among each charge holding element in the timing of time [to be shown in drawing 3] T_{RO2} is read to a vertical register. As shown in drawing 4 (b), the electric charge currently held at charge holding element $CR_{1 \text{ corresponding to photo detectors of odd lines, such as photo detector } PD_{1,i}, PD_{3,i}, \text{ and } —,i}$, $CR_{3,i}$, and — is transmitted to vertical transfer register 32_{-i}, respectively.

[0036]Next, in a vertical transfer part, after performing vertical transfer by a party, the signal charge accumulated in the exposure time A1 with the photo detector of even lines among each charge holding element in the timing of time T_{RO3} is read to a vertical register. As shown in drawing 4 (c), the electric charge currently held at charge holding element $CR_{2 \text{ corresponding to photo detectors of even lines, such as photo detector } PD_{2,i}, PD_{4,i}, \text{ and } —,i}$, $CR_{4,i}$, and — is transmitted to vertical transfer register 32_{-i}, respectively. Thereby, the signal charge of the photo detector of odd lines and even lines accumulated in the same exposure time A1 is mixed in a vertical transfer register.

[0037]Next, the stored charge of the photo detector equivalent to odd lines in the electric charge accumulated in the exposure time B1 is read from timing each photo detector of time T_{RO4} to the vertical transfer register provided according to each photo detector. And after performing vertical transfer by a party in a vertical transfer part, the stored charge of the photo detector equivalent to even lines in the electric charge accumulated in the exposure time B1 in the timing of time T_{RO5} is read from each photo detector to a vertical transfer register. Thereby, the signal charge of the photo detector of odd lines and even lines accumulated in the same exposure time B1 is mixed in a vertical transfer register.

[0038]As shown in drawing 4 (d), the signal charge accumulated in photo detectors of odd lines, such as photo detector $PD_{1,i}$, $PD_{3,i}$, and —, is transmitted to vertical transfer register 32_{-i}, respectively. In [the signal charge accumulated in photo detectors of even lines such as photo detector $PD_{2,i}$, $PD_{4,i}$, and —, as shown in drawing 4 (e) is transmitted to vertical transfer register 32_{-i}, respectively, and] vertical transfer register 32_{-i}, It is mixed with the signal charge accumulated by photo detector PD[of odd lines] $_{1 \text{ sent by vertical transfer, } i}$, $PD_{3,i}$, and —.

[0039]The electric charge accumulated in the vertical transfer register at the exposure time A1 and the electric charge accumulated in the exposure time B1 are held by turns by a series of operations described above. By and the vertical transfer after read-out is completed, the transmission between vertical register horizontal registers, and horizontal transfer. It is transmitted to the electric charge detection amplifier 36 at a time series, the result of electric charge detection is amplified by the output amplifier 38, and the signal charge accumulated in the exposure time A1 and the exposure time B1 is outputted as the picture signal S30a.

[0040]Thus, the light volume-sensitivity characteristic which shows the exposure time A1 and each signal charge of B1 to drawing 5 (a) and (b) from the difference in each exposure time to the amount of input light is acquired. And addition/compensation process is performed to these signals by the digital disposal circuit 40 established in the latter part of the solid state image pickup device 30a, and the light volume-sensitivity characteristic shown in drawing 5 (c) can be acquired as the characteristic of the whole solid state camera. That is, since the exposure time A1 and the exposure time B1 can be set up arbitrarily, they can control arbitrarily inclination of

the sensitivity characteristic corresponding to each exposure time to be shown in drawing 5 (a) and (b). According to this, as shown in drawing 5 (c), inclination can set up the light volume-sensitivity characteristic of the whole solid state camera arbitrarily, and it can realize the optimum control of a dynamic range.

[0041]In the solid state camera of this embodiment shown in drawing 1, processing of integration treatment, peak detection, etc. is performed in the luminance-signal detector circuit 80 to the luminance signal S40 from the digital disposal circuit 40, As for the detection signal S80 from the luminance-signal detector circuit 80, in the arithmetic circuit 90, the luminosity of a picture, the judgment of contrast and a backlight state, etc. are performed. To the image state judged in the arithmetic circuit 90, speed control of an electronic shutter, and the mechanism iris control of the object lens 10, Or the control signal S90 which performs gain control of AGC, etc. is generated, and each control is automatically performed according to image pick-up conditions and the image pick-up purpose by feeding this back to the object lens 10, the timing generating circuit 60a, and the digital disposal circuit 40.

[0042]With the control signal S90 generated in the solid state camera of this embodiment which has such a feature according to the result which carried out data processing in the arithmetic circuit 90 based on the detection signal S80 from the detector circuit 80, and it. The sensitivity ratio of the exposure time A1 and the exposure time B1 can be set up arbitrarily, and the dynamic range of a solid state camera can be optimized according to an image pick-up situation, the image pick-up purpose, etc. For example, as shown in drawing 6 (a), the contrast of a picture in a small and state dark to the whole. It is possible to consider it as exposure setting out of only the exposure time A1, or for the contrast of a picture to be small as shown in the figure (b), but to use for the whole the signal with which it is accepted whether the sensitivity ratio of the exposure time A1 and the exposure time B1 is made the same exposure time A1 (or only in case of B1) in the bright state. The dynamic range of a picture is improvable by enlarging the sensitivity ratio of the exposure time A1 and the exposure time B1, when the contrast of a picture is large as shown in the figure (c) on the contrary, It is also effective to change the sensitivity ratio of the exposure time A1 and the exposure time B1 according to the degree of contrast.

[0043]According to this embodiment, as explained above, the solid state image pickup device 30a is irradiated with incident light via the object lens 10 and the light filter 20, and the solid state image pickup device 30a divides exposure time into plurality, generates the picture signal S30a according to a storing signal electric charge in each period, and inputs it into the digital disposal circuit 40. Level and Vertical Synchronizing signals HD and VD which were generated by the synchronizing signal generation circuit 70 are supplied to the timing generating circuit 60a and the digital disposal circuit 40, respectively, A timing generating circuit generates the synchronized signal pulse signal S60a according to it, after amplifying by the drive circuit 50, it inputs into the solid state image pickup device 30a, and the operation timing is controlled, and the digital disposal circuit 40 outputs composite video signal S_{VDO} which added the synchronized signal to the picture signal. The luminance-signal detector circuit 80 detects the luminance signal S40 from the digital disposal circuit 40, and outputs the detection signal S80, The arithmetic circuit 90 carries out data processing of the detection signal S80, and the luminosity, the contrast, and the backlight state of a picture are judged, Since the control signal S90 is generated, it feeds back to an object lens, the timing generating circuit 60a, and the digital disposal circuit 40 and exposure control is performed, according to the state of an image pick-up, optimization of a dynamic range is realizable.

[0044]This invention is not limited by the embodiment mentioned above, can set two or more exposure time, i.e., an electric charge storage period, for example as per pixel, and can apply it to the solid state camera each exposure time or at large which has a function which can control setting out of one exposure time among those at least. Although the electric charge storage period was divided only in two periods for simplification and a solid state camera which controls the exposure time of these both, and a method for the same were taken up in the above explanation, It cannot be overemphasized that this invention is applicable to the imaging device

which this invention is not limited to this, divides an electric charge storage period in two or more periods, and controls each period or at least one period.

[0045]

[Effect of the Invention]As explained above, according to a solid state camera of this invention, and a method for the same, the sensitivity ratio of the exposure time divided into plurality according to the decision result of an image state by setting up arbitrarily. Since the balance of the light volume-sensitivity characteristic of an inside low luminance area and a high luminance region can be set up freely, there is an advantage which can optimize the dynamic range of an imaging device according to the situation of photographic subjects, such as a backlight state and size of contrast.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a circuit diagram showing one embodiment of the solid state camera concerning this invention.
[Drawing 2]It is a plot plan showing the internal configuration of the solid state image pickup device in this invention.
[Drawing 3]It is a wave form chart showing the operation timing of the solid state image pickup device in this invention.
[Drawing 4]It is a key map showing operation of the charge storage in the solid state image pickup device in this invention, and charge transfer.
[Drawing 5]It is a graph which shows the light volume-sensitivity characteristic of the solid state camera of this invention.
[Drawing 6]It is a key map showing the luminosity of a photographic subject, and the situation of contrast.
[Drawing 7]It is a block diagram showing an example of the conventional solid state camera.
[Drawing 8]It is a plot plan showing the internal configuration of the conventional solid state image pickup device.
[Drawing 9]It is a wave form chart showing the operation timing of the conventional solid state image pickup device.
[Drawing 10]It is a key map showing operation of the charge storage in the conventional solid state image pickup device, and charge transfer.
[Drawing 11]It is a graph which shows the light volume-sensitivity characteristic of the conventional solid state camera.
[Description of Notations]

* NOTICES *

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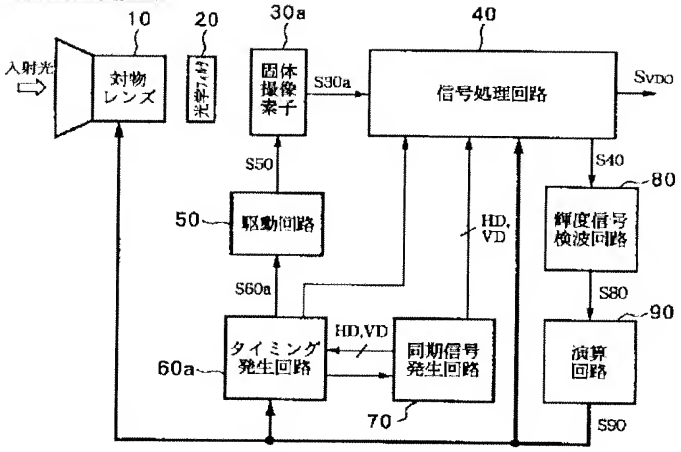
damages caused by the use of this translation.

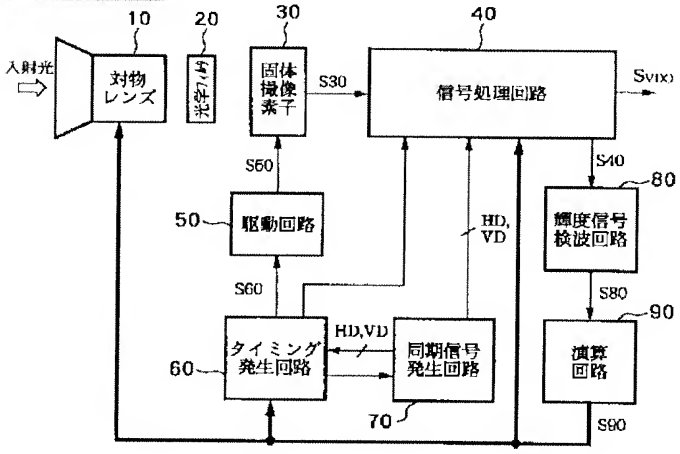
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

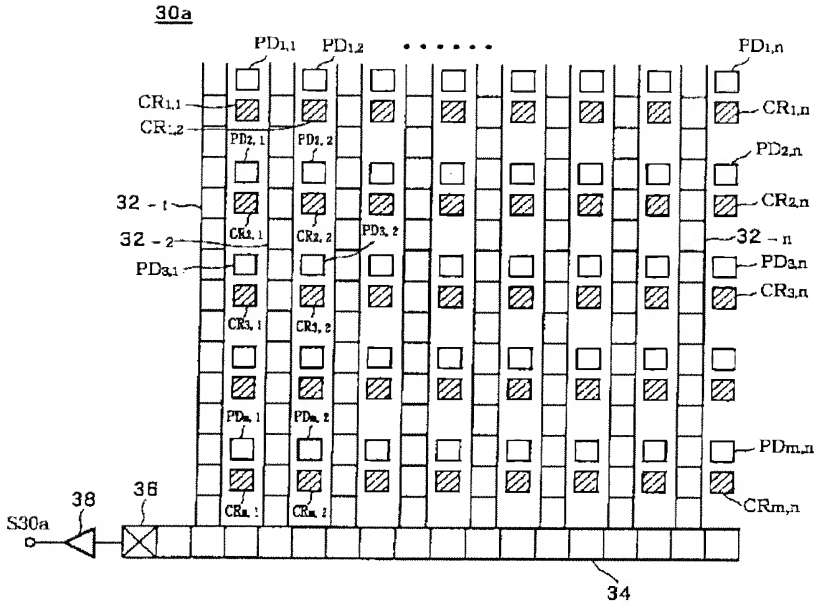
[Drawing 1]



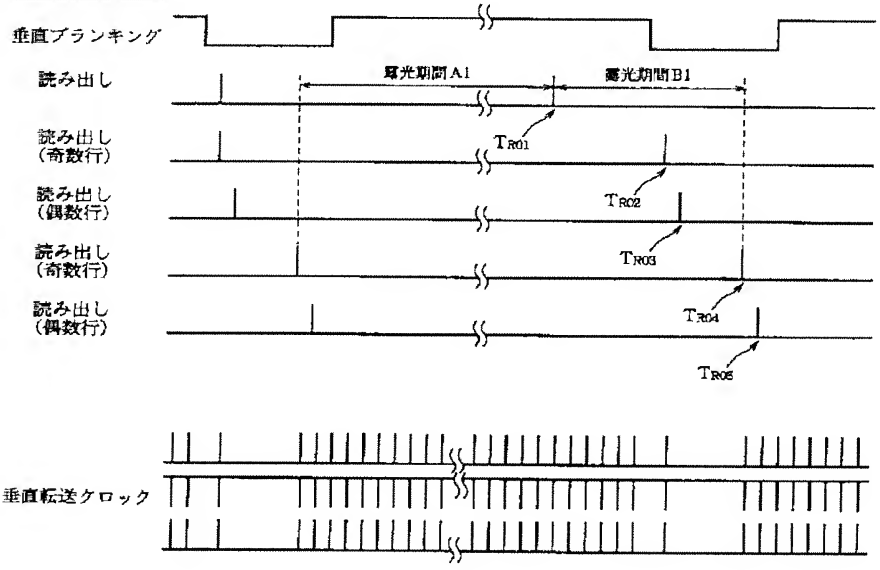
[Drawing 7]



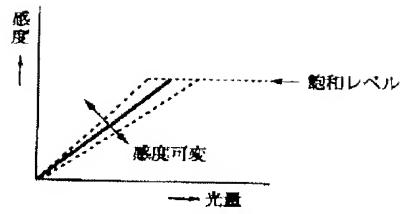
[Drawing 2]



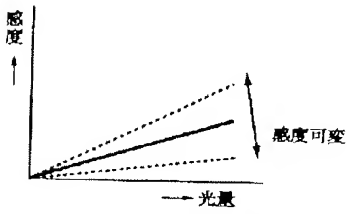
[Drawing 3]



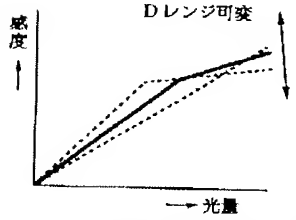
[Drawing 5]



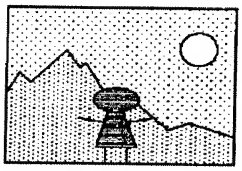
(A) 蓄積期間 A1 の光量－感度特性



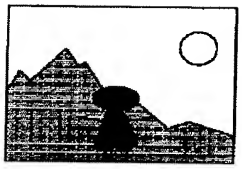
(B) 露光期間 B1 の光量－感度特性



(C) 加算／補正処理後の光量－感度特性



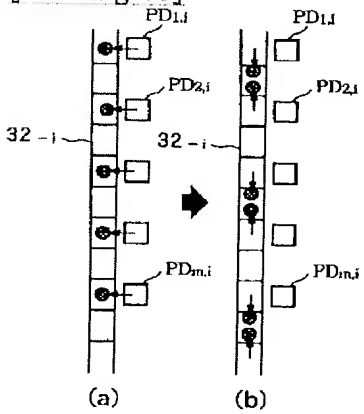
(a)



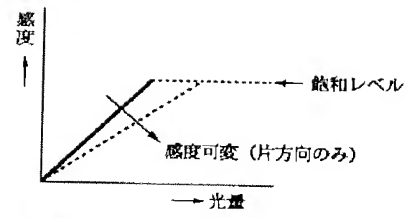
(b)

(c)

[Drawing 10]

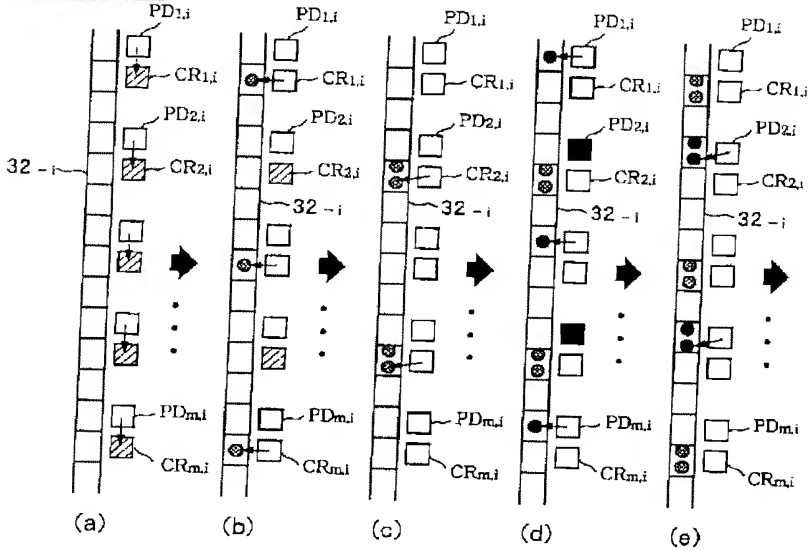


[Drawing 11]

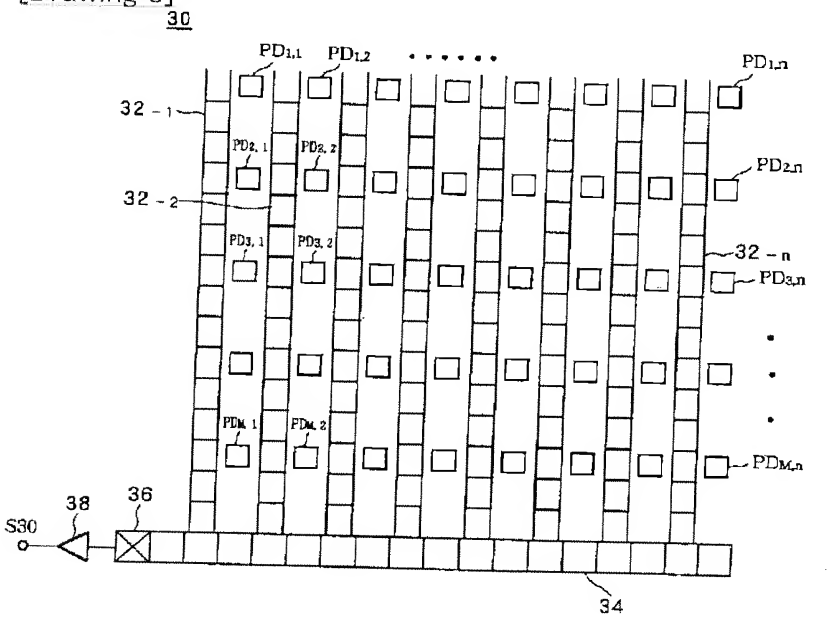


蓄積期間 A の光量－感度特性

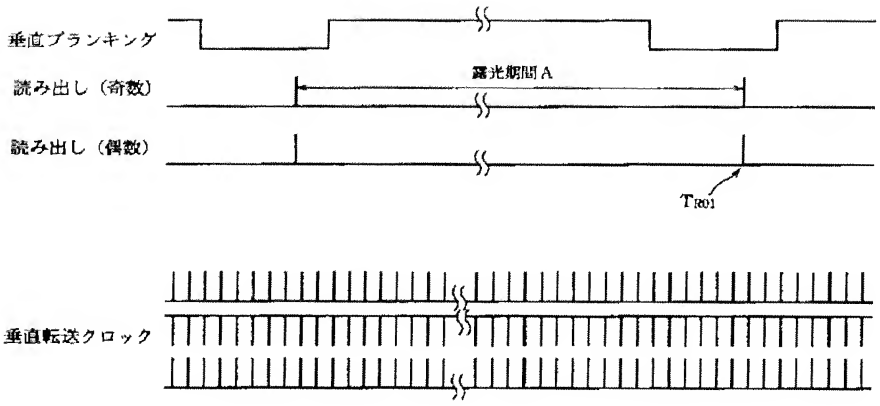
[Drawing 4]



[Drawing 8]



[Drawing 9]



[Translation done.]

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Ｈ０１Ｌ　27/148		Ｈ０１Ｌ　27/14	Ｂ

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(71)出願人　000002185
ソニー株式会社
東京都品川区北品川６丁目７番35号

(72)発明者　森　浩史
東京都品川区北品川６丁目７番35号　ソニー株式会社内

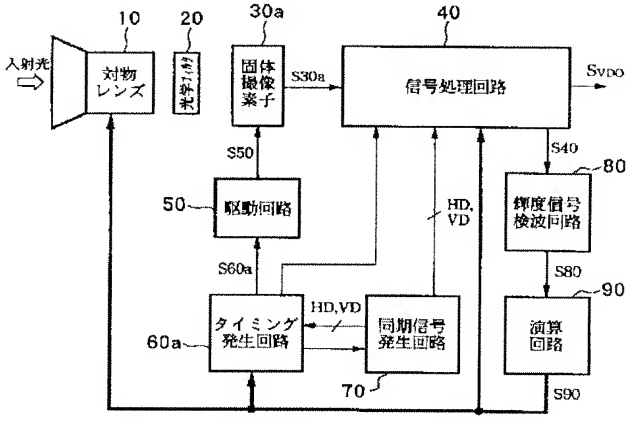
(74)代理人　弁理士　佐藤　隆久

(54)【発明の名称】　固体撮像装置およびその撮像方法

(57)【要約】

【課題】　複数に分割された露光期間の感度比を入射光量に応じて自由に設定でき、撮像状態に応じてダイナミックレンジを最適化できる固体撮像装置およびその撮像方法を実現する。

【解決手段】　固体撮像素子３０ａは露光期間を複数に分割し、各期間で蓄積した電荷に応じて画像信号Ｓ３０ａを生成し、同期信号発生回路７０により生成した水平および垂直同期信号ＨＤ，ＶＤはタイミング発生回路６０ａおよび信号処理回路４０に供給し、動作タイミングを制御する。輝度信号検波回路８０は信号処理回路４０からの輝度信号Ｓ４０を検波して検波信号Ｓ８０を出力し、演算回路９０は検波信号Ｓ８０を演算処理し、画像の明るさ、コントラストや逆光状態を判定し、制御信号Ｓ９０を生成し、対物レンズ、タイミング発生回路６０ａおよび信号処理回路４０にフィードバックし、露光制御を行う。



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【特許請求の範囲】

【請求項１】電荷蓄積期間中に撮像対象物からの入射光量に応じて受光素子に蓄積した電荷を転送素子を介して転送し、画像信号として出力する固体撮像装置であって、

上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記入射光量に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御する制御手段を有する固体撮像装置。

【請求項２】上記画像信号を検波する検波手段を有し、上記制御手段は、当該検波手段の出力信号に応じて、上記分割した期間の内、少なくとも一つの期間の時間長を制御する請求項１記載の固体撮像装置。

【請求項３】上記受光素子に蓄積した電荷を保持する電荷保持手段と、

上記第１期間終了後の第１のタイミングで上記受光素子に蓄積した電荷を上記保持手段に転送し保持させ、第２のタイミングで上記電荷保持手段に保持されている電荷を上記転送素子に転送し、上記第２期間終了後の第３のタイミングで上記第２期間中に上記受光素子に蓄積した電荷を上記転送素子に転送して出力させる転送制御手段とを有する請求項１記載の固体撮像装置。

【請求項４】画素ごとに設けられ、マトリックス状に配置された複数の受光素子からなる受光部と、

列方向に連なって上記受光部の受光素子列ごとに配置され、電荷蓄積期間中に撮像対象物からの入射光量に応じて上記受光素子に蓄積した電荷を列方向に転送する転送素子からなる垂直転送部と、

上記垂直転送部の転送素子から送られてきた電荷を行方向に転送して、時系列の画像信号として出力する転送素子からなる水平転送部と、

上記水平転送部により出力された画像信号を検波する検波手段と、

上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記検波手段の出力信号に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御する露光時間制御手段と、

上記受光素子に蓄積した電荷を保持する電荷保持手段と、

上記第１期間終了後の第１のタイミングで当該第１期間中に上記受光部の受光素子に蓄積した電荷を上記電荷保持手段に転送し保持させ、第２のタイミングで上記電荷保持手段に保持されている電荷を上記垂直転送部の転送素子に転送し、上記第２期間終了後の第３のタイミングで当該第２期間中に上記受光部の受光素子に蓄積した電荷を上記垂直転送部の転送素子に転送する転送制御手段とを有する固体撮像装置。

【請求項５】上記第２のタイミングは、上記垂直転送部に前のフィールドの画像信号に応じた蓄積電荷の転送終了後に設定されている請求項４記載の固体撮像装置。

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【請求項６】上記第１のタイミングで上記受光部の受光素子に蓄積した電荷が上記電荷保持手段に転送した後、各受光素子の電荷がクリアされ、次の電荷蓄積期間が開始する請求項４記載の固体撮像装置。

【請求項７】画素ごとに設けられ、マトリックス状に配置された複数の受光素子からなる受光部と、

列方向に連なって上記受光部の受光素子列ごとに配置され、電荷蓄積期間中に撮像対象物からの入射光量に応じて上記受光素子に蓄積した電荷を列方向に転送する転送素子からなる垂直転送部と、

上記垂直転送部の転送素子から送られてきた電荷を行方向に転送して、時系列の画像信号として出力する転送素子からなる水平転送部と、

上記水平転送部により出力された画像信号を検波する検波手段と、

上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記検波手段の出力信号に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御する露光時間制御手段と、

上記受光素子に蓄積した電荷を保持する電荷保持手段と、

上記第１期間終了後の第１のタイミングで当該第１期間中に上記受光部の受光素子に蓄積した電荷を上記電荷保持手段に転送し保持させ、第２のタイミングで上記電荷保持手段に保持されている電荷の内、奇数行の受光素子で蓄積した電荷を上記垂直転送部の転送素子に転送し、第３のタイミングで上記電荷保持手段に保持されている電荷の内、偶数行の受光素子で蓄積した電荷を上記垂直転送部の転送素子に転送し、上記第２期間終了後の第４のタイミングで当該第２期間中に上記受光部の奇数行の受光素子に蓄積した電荷を上記垂直転送部の転送素子に転送し、第５のタイミングで上記第２期間中に上記受光部の偶数行の受光素子に蓄積した電荷を上記垂直転送部の転送素子に転送する転送制御手段とを有する固体撮像装置。

【請求項８】上記電荷保持手段は、上記受光部の受光素子ごとに設けられ、上記第１のタイミングで上記受光部の各受光素子から送られてきた電荷を格納する電荷保持素子により構成されている請求項７記載の固体撮像装置。

【請求項９】上記第１のタイミングで上記受光部の受光素子に蓄積した電荷が上記電荷保持手段に転送した後、各受光素子の電荷がクリアされ、次の電荷蓄積期間が開始する請求項７記載の固体撮像装置。

【請求項１０】上記第２のタイミングで上記電荷保持手段に保持されている奇数行の受光素子の蓄積電荷が上記垂直転送部の転送素子に転送した後、上記垂直転送部において一回の転送動作が行われる請求項７記載の固体撮像装置。

【請求項１１】上記転送動作が行われた後、上記垂直転

送部の各転送素子に保持されている奇数行受光素子の蓄積電荷が、上記第３のタイミングで上記電荷保持手段から送られてきた偶数行の受光素子の蓄積電荷と混合される請求項１０記載の固体撮像装置。

【請求項１２】上記第４のタイミングで上記奇数行の受光素子の蓄積電荷が上記垂直転送部の転送素子に転送した後、上記垂直転送部において一回の転送動作が行われる請求項７記載の固体撮像装置。

【請求項１３】上記転送動作が行われた後、上記垂直転送部の各転送素子に保持されている奇数行受光素子の蓄積電荷が、上記第５のタイミングで上記偶数行の受光素子から送られてきた蓄積電荷と混合される請求項１２記載の固体撮像装置。

【請求項１４】電荷蓄積期間中に撮像対象物からの入射光量に応じて受光素子に電荷を蓄積し、蓄積した電荷を転送素子を介して転送し、画像信号として出力する固体撮像装置の撮像方法であって、

上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記入射光量に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御する固体撮像装置の撮像方法。

【請求項１５】マトリックス状に配置された複数の受光素子が電荷蓄積期間中に撮像対象物からの入射光量に応じて電荷を蓄積し、蓄積した電荷を上記受光素子の列ごとに配置された垂直転送素子によって上記マトリックスの列方法に転送し、上記垂直転送素子により送られてきた電荷を水平転送素子によって上記マトリックスの行方向に転送し、時系列の画像信号として出力する固体撮像装置の撮像方法であって、

上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記画像信号に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御し、

上記第１期間終了後の第１のタイミングで上記受光素子に蓄積した電荷を保持し、

第２のタイミングで上記保持された電荷を上記垂直転送素子に転送し、

上記第２期間終了後の第３のタイミングで上記受光素子に蓄積した電荷を上記垂直転送素子に転送する固体撮像装置の撮像方法。

【請求項１６】上記第１のタイミングで上記受光素子に蓄積した電荷を上記電荷保持手段に転送した後、上記受光素子の電荷をクリアし、次の電荷蓄積期間を開始する請求項１５記載の固体撮像装置の撮像方法。

【請求項１７】上記第２のタイミングは、上記垂直転送素子に前のフィールドの画像に応じた蓄積電荷の転送終了後に設定されている請求項１５記載の固体撮像装置の撮像方法。

【請求項１８】マトリックス状に配置された複数の受光素子が電荷蓄積期間中に撮像対象物からの入射光量に応じて電荷を蓄積し、蓄積した電荷を上記受光素子の列ごとに配置された垂直転送素子によって上記マトリックスの列方法に転送し、上記垂直転送素子により送られてきた電荷を水平転送素子によって上記マトリックスの行方向に転送し、時系列の画像信号として出力する固体撮像装置の撮像方法であって、

上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記画像信号に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御し、

上記第１期間終了後の第１のタイミングで上記受光素子に蓄積した電荷を保持し、

第２のタイミングで上記保持された電荷の内、奇数行の受光素子で蓄積した電荷を上記垂直転送素子に転送し、

第３のタイミングで上記保持された電荷の内、偶数行の受光素子で蓄積した電荷を上記垂直転送素子に転送し、

上記第２期間終了後の第４のタイミングで奇数行の受光素子に蓄積した電荷を上記垂直転送素子に転送し、

第５のタイミングで偶数行の受光素子に蓄積した電荷を上記垂直転送素子に転送する固体撮像装置の撮像方法。

【請求項１９】上記第１のタイミングで上記受光素子に蓄積した電荷を上記電荷保持手段に転送した後、上記受光素子の電荷をクリアし、次の電荷蓄積期間を開始する請求項１８記載の固体撮像装置の撮像方法。

【請求項２０】上記第２のタイミングは、上記垂直転送素子に前のフィールドの画像に応じた蓄積電荷の転送終了後に設定されている請求項１８記載の固体撮像装置の撮像方法。

【請求項２１】上記第２のタイミングでの転送動作の後、上記垂直転送素子により一回の転送動作を行い、転送後各転送素子の電荷を上記第３のタイミングで送られてきた電荷と混合する請求項１８記載の固体撮像装置の撮像方法。

【請求項２２】上記第４の転送動作の後、上記垂直転送素子により一回の転送動作を行い、転送後の各転送素子の電荷を上記第５のタイミングで送られてきた電荷と混合する請求項１８記載の固体撮像装置の撮像方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、固体撮像装置、例えば、電荷蓄積期間を複数の期間に分割し、入射光量、画像のコントラストなどに応じて分割した複数の期間の内少なくとも一つの期間における露光時間を制御することにより、各期間の入射光量－感度特性を制御し、入射光量に対して飽和しにくく、ダイナミックレンジが広くできる固体撮像装置およびその撮像方法に関するものである。

【０００２】

【従来の技術】ＣＣＤ（Charge Coupled Device:電荷結合デバイス）などを用いた固体撮像装置において、フォトダイオードなどの受光素子を用いて、撮像対象物からの入射光に応じて電荷を蓄積し、転送素子などにより蓄

積した信号電荷を時系列の電気信号に変換し、画像信号として出力する。

【０００３】図７は従来の固体撮像装置の一構成例を示すブロック図である。図示のように、本例の固体撮像装置は、対物レンズ１０、光学フィルタ２０、固体撮像素子３０、信号処理回路４０、駆動回路５０、タイミング発生回路６０、同期信号発生回路７０、輝度信号検波回路８０および演算回路９０により構成されている。

【０００４】同期信号発生回路７０により水平同期信号ＨＤと垂直同期信号ＶＤがそれぞれ発生される。タイミング発生回路６０は同期信号発生回路７０からの水平同期信号ＨＤおよび垂直同期信号ＶＤに同期して動作し、固体撮像装置全体の動作タイミングを制御する駆動パルス信号Ｓ６０を発生する。駆動回路５０は、タイミング発生回路６０からの駆動パルス信号Ｓ６０を電流／振幅増幅して、固体撮像素子３０に入力する。

【０００５】撮像対象物からの入射光は、対物レンズ１０および光学フィルタ２０を介して固体撮像素子３０に照射される。固体撮像素子３０は、駆動回路５０により増幅された駆動パルス信号Ｓ５０により設定したタイミングで、入射光量に応じた電気信号である画像信号Ｓ３０を生成し、信号処理回路４０に出力する。信号処理回路４０は、固体撮像素子３０からの画像信号を処理して、それに同期信号発生回路７０からの水平同期信号ＨＤおよび垂直同期信号ＶＤを加えた後、ビデオ信号S_{VDO}として出力する。

【０００６】輝度信号検波回路８０は、信号処理回路４０において処理途中の輝度信号情報を含む映像信号（以下、単に輝度信号という）Ｓ４０を受けて、それを検波し、検波信号Ｓ８０を出力する。演算回路９０は、輝度信号検波回路８０からの検波信号Ｓ８０を受けて、それに基づき画像の明るさ、コントラストや逆光状態の判定を行う。判定結果に応じて、シャッタスピードやＡＧＣの設定を行う制御信号Ｓ９０を発生し、対物レンズ１０、タイミング発生回路６０および信号処理回路４０にそれぞれ供給し、このフィードバックにより露光制御を行う。

【０００７】図８は、従来の固体撮像装置に用いられている固体撮像素子３０の構造を示す配置図である。図示のように、固体撮像素子３０は、マトリクス状に配置された複数、例えば、（ｍ×ｎ、ｍ，ｎは正整数である）個の受光素子$PD_{1,1}$，$PD_{1,2}$，…，$PD_{1,n}$，$PD_{2,1}$，$PD_{2,2}$，…，$PD_{3,1}$，$PD_{3,2}$，…，$PD_{m,1}$，$PD_{m,2}$，…，$PD_{m,n}$により構成されている受光部、受光部の列方向に連なって、受光素子の各列ごとに設けられている転送素子からなる垂直転送部３２、垂直転送部から送られてきた電荷を行方向に転送する転送素子からなる水平転送部３４、水平転送部の終端に設けられ、電荷の有無を検出する電荷検出アンプ３６、電荷検出アンプ３６からの信号を出力する出力アンプ３８により構成されている。なお、垂直転送部３２は、例えば、マトリクス状に配置されている受光素子の列に応じて、マトリックスの列方向に配置されているｎ列の転送素子32_{-1}，32_{-2}，…，32_{-n}により構成されている。

【０００８】即ち、固体撮像素子３０は一般的なインターライン方式の固体撮像素子で、垂直方向に隣り合った受光素子の信号電荷を垂直転送部の垂直転送素子内部で混合するフィールド読み出し動作を前提としている。

【０００９】受光素子$PD_{1,1}$，$PD_{1,2}$，…，$PD_{1,n}$，$PD_{2,1}$，$PD_{2,2}$，…，$PD_{3,1}$，$PD_{3,2}$，…，$PD_{m,1}$，$PD_{m,2}$，…，$PD_{m,n}$は、例えば、露光期間（電荷蓄積期間）中に入射した光量に応じて所定量の電荷を蓄積するフォトダイオードなどの光センサにより構成され、垂直転送素子および水平転送素子は、例えば、レジスタにより構成されている。出力アンプ３８からの出力信号は、固体撮像素子３０により発生した画像信号Ｓ３０である。

【００１０】図９は固体撮像素子３０の動作タイミングを示す波形図、図１０は固体撮像素子３０における電荷転送および混合の動作を示す概念図である。以下、これらの図面を参照しつつ、本例の固体撮像素子３０における電荷蓄積、転送および混合動作について説明する。図９に示すように、露光期間Ａに受光部の各受光素子に蓄積した電荷が時間T_{RO1}のタイミングで垂直転送部の転送素子（以下、単に垂直転送レジスタという）に読み出される。この動作は垂直転送レジスタ内の電荷転送が終了した後の垂直ブランキング期間に入って初めて可能となり、垂直ブランキング以外には行うことができない。また、この読み出し直後に空になった受光素子は次１フィールドの蓄積動作を開始する。

【００１１】同一露光期間Ａに蓄積された信号電荷の内、奇数行の受光素子で蓄積した信号電荷と偶数行の受光素子で蓄積した信号電荷が垂直転送レジスタ内で混合されたのち、垂直転送、垂直レジスター水平レジスタ間転送および水平転送によって、露光期間Ａと露光期間Ｂにそれぞれ蓄積した信号電荷は時系列に電荷検出アンプ３６に転送され、電荷検出の結果が出力アンプ３８により増幅され、画像信号Ｓ３０として出力される。

【００１２】

【発明が解決しようとする課題】ところで、上述した従来の固体撮像装置においては、１フィールドの画像を構成する各画素のの蓄積期間は各フィールド当たり１期間のみで、入力光量に対する感度特性は図１１に示すように、一時の直線となる。この場合、入力光量がある程度大きくなると、受光素子の出力が飽和してしまい、画像の高輝度の部分が潰れてしまう。画像の飽和を回避するためには、電子シャッタなどの露光制御機能を利用して光量に対する感度特性を抑えてしまう使い方があるが、反対に暗い部分での感度が不足してしまい、十分な出力

レベルを得ることができなくなる。即ち、１画面中の輝度レベルの差が大きい被写体を撮像する場合に、十分なダイナミックレンジを得ることができないという不利益がある。

【００１３】また、図７に示すように、信号処理回路４０からの輝度信号Ｓ４０は輝度信号検波回路８０において積分処理やピーク検出などの処理が施され、輝度信号検波回路８０からの検波信号Ｓ８０は演算回路９０において、画像の明るさやコントラスト、逆光状態の判定などが行われる。演算回路９０において判定された画像状態に対して、電子シャッタのスピード制御や対物レンズ１０のメカアイリス制御、またはＡＧＣのゲイン制御などが自動的に行われるが、従来の固体撮像装置が選択できる露光設定は一通りであるため、１画面中の輝度レベルの差が大きい被写体を撮像する場合には、十分なダイナミックレンジを得ることができないという問題点が残ったままである。

【００１４】本発明は、かかる事情に鑑みてなされたものであり、その目的は、画像状態の判定結果に応じて複数に分割された露光期間の感度比を任意に設定することで、入射光量に応じて感度特性を自由に設定でき、撮像状態に応じてダイナミックレンジを最適化できる固体撮像装置およびその撮像方法を提供することにある。

【００１５】

【課題を解決するための手段】上記目的を達成するため、本発明の固体撮像装置は、電荷蓄積期間中に撮像対象物からの入射光量に応じて受光素子に蓄積した電荷を転送期間中に転送素子を介して転送し、画像信号として外部に出力する固体撮像装置であって、上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記入射光量に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御する制御手段を有する。

【００１６】また、本発明では、好適には上記画像信号を検波する検波手段を有し、上記制御手段は、当該検波手段の出力信号に応じて、上記分割した期間の内、少なくとも一つの期間の時間長を制御する。また、本発明の固体撮像装置は、上記受光素子に蓄積した電荷を保持する電荷保持手段と、上記第１期間終了後の第１のタイミングで上記受光素子に蓄積した電荷を上記保持手段に転送し保持させ、第２のタイミングで上記電荷保持手段に保持されている電荷を上記転送素子に転送し、上記第２期間終了後の第３のタイミングで上記第２期間中に上記受光素子に蓄積した電荷を上記転送素子に転送して出力させる転送制御手段とを有する。

【００１７】また、本発明の固体撮像装置は、画素ごとに設けられ、マトリックス状に配置された複数の受光素子からなる受光部と、列方向に連なって上記受光部の受光素子列ごとに配置され、電荷蓄積期間中に撮像対象物からの入射光量に応じて上記受光素子に蓄積した電荷を列方向に転送する転送素子からなる垂直転送部と、上記垂直転送部の転送素子から送られてきた電荷を行方向に転送して、時系列の画像信号として出力する転送素子からなる水平転送部と、上記水平転送部により出力された画像信号を検波する検波手段と、上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記検波手段の出力信号に応じて上記分割した期間の内、少なくとも一つの期間の露光時間を制御する露光時間制御手段と、上記受光素子に蓄積した電荷を保持する電荷保持手段と、上記第１期間終了後の第１のタイミングで当該第１期間中に上記受光部の受光素子に蓄積した電荷を上記電荷保持手段に転送し保持させ、第２のタイミングで上記電荷保持手段に保持されている電荷を上記垂直転送部の転送素子に転送し、上記第２期間終了後の第３のタイミングで当該第２期間中に上記受光部の受光素子に蓄積した電荷を上記垂直転送部の転送素子に転送する転送制御手段とを有する。

【００１８】また、本発明の固体撮像装置は、画素ごとに設けられ、マトリックス状に配置された複数の受光素子からなる受光部と、列方向に連なって上記受光部の受光素子列ごとに配置され、電荷蓄積期間中に撮像対象物からの入射光量に応じて上記受光素子に蓄積した電荷を列方向に転送する転送素子からなる垂直転送部と、上記垂直転送部の転送素子から送られてきた電荷を行方向に転送して、時系列の画像信号として出力する転送素子からなる水平転送部と、上記水平転送部により出力された画像信号を検波する検波手段と、上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記検波手段の出力信号に応じて上記分割した期間の内、少なくとも一つの期間の露光時間を制御する露光時間制御手段と、上記受光素子に蓄積した電荷を保持する電荷保持手段と、上記第１期間終了後の第１のタイミングで当該第１期間中に上記受光部の受光素子に蓄積した電荷を上記電荷保持手段に転送し保持させ、第２のタイミングで上記電荷保持手段に保持されている電荷の内、奇数行の受光素子で蓄積した電荷を上記垂直転送部の転送素子に転送し、第３のタイミングで上記電荷保持手段に保持されている電荷の内、偶数行の受光素子で蓄積した電荷を上記垂直転送部の転送素子に転送し、上記第２期間終了後の第４のタイミングで当該第２期間中に上記受光部の奇数行の受光素子に蓄積した電荷を上記垂直転送部の転送素子に転送し、第５のタイミングで上記第２期間中に上記受光部の偶数行の受光素子に蓄積した電荷を上記垂直転送部の転送素子に転送する転送制御手段とを有する。

【００１９】また、本発明の固体撮像装置の撮像方法は、電荷蓄積期間中に撮像対象物からの入射光量に応じて受光素子に電荷を蓄積し、蓄積した電荷を転送素子を介して転送し、画像信号として出力する。上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分

割し、上記入射光量に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御する。

【００２０】さらに、本発明の固体撮像装置の撮像方法は、マトリックス状に配置された複数の受光素子が電荷蓄積期間中に撮像対象物からの入射光量に応じて電荷を蓄積し、蓄積した電荷を上記受光素子の列ごとに配置された垂直転送素子によって上記マトリックスの列方法に転送し、上記垂直転送素子により送られてきた電荷を水平転送素子によって上記マトリックスの行方向に転送し、時系列の画像信号として出力する固体撮像装置の撮像方法であって、上記電荷蓄積期間を少なくとも第１期間と第２期間の二つの期間に分割し、上記画像信号に応じて上記分割した期間の内、少なくとも一つの期間の時間長を制御し、上記第１期間終了後の第１のタイミングで上記受光素子に蓄積した電荷を保持し、第２のタイミングで上記保持された電荷の内、奇数行の受光素子で蓄積した電荷を上記垂直転送素子に転送し、第３のタイミングで上記保持された電荷の内、偶数行の受光素子で蓄積した電荷を上記垂直転送素子に転送し、上記第２期間終了後の第４のタイミングで奇数行の受光素子に蓄積した電荷を上記垂直転送素子に転送し、第５のタイミングで偶数行の受光素子に蓄積した電荷を上記垂直転送素子に転送する。

【００２１】本発明によれば、固体撮像装置の撮像期間は複数の、例えば、少なくとも二つの期間に分割され、入射光量に応じて分割した複数の期間の内、少なくとも一つの期間の露光時間が制御されるので、被写体からの入射光量および撮像条件、撮像目的などに応じて複数に分割した露光期間の感度比が任意に設定でき、固体撮像装置のダイナミックレンジの最適化が実現できる。

【００２２】具体的に、例えば、画素ごとに設けられマトリックス状に配置された受光素子からなる受光部、露光期間中に受光素子に蓄積した信号電荷を垂直方向に転送および混合する垂直転送レジスタ、垂直転送レジスタから送られてきた信号電荷を水平方向に転送する水平転送レジスタからなる固体撮像素子に、水平転送レジスタから出力された画像信号の輝度信号を検波する検波手段が付け加えられ、検波手段の検波結果に応じて分割された複数の期間の内、少なくとも一つの期間における露光期間を制御することにより、各露光期間の感度比を設定でき、固体撮像装置のダイナミックレンジを最適化することができる。

【００２３】また、分割された複数の期間の露光時間を自由に設定するため、固体撮像素子には、各受光部の受光素子ごとにそれぞれの受光素子の蓄積電荷を一時保持する電荷保持素子が設けられている。例えば、一例として、電荷蓄積時間が第１期間と第２期間の二つに分割した場合、第１期間終了後の第１のタイミングで各受光素子に蓄積した信号電荷がすべて電荷保持素子に転送される。そして、垂直転送レジスタにおける１フィールドの垂直転送が終了した後の第２のタイミングおよび第３のタイミングにおいて、電荷保持素子内の奇数行および偶数行の保持電荷が順次垂直転送レジスタに転送され、垂直転送レジスタにおいて混合される。さらに、第２期間終了後の第４および第５のタイミングにおいて、奇数行および偶数行の受光素子に蓄積した信号電荷が順次垂直転送レジスタに転送され、垂直転送レジスタにおいて混合された後、水平レジスタに転送され、さらに水平転送レジスタにより時系列の画像信号として出力される。このように分割された複数の期間の露光時間が任意に設定することができ、固体撮像素子の入射光量－感度特性を任意に設定でき、ダイナミックレンジの最適化が実現できる。

【００２４】

【発明の実施の形態】図１は本発明に係る固体撮像装置の一実施形態を示す回路図である。図示のようにように、本例の固体撮像装置は、対物レンズ１０、光学フィルタ２０、固体撮像素子３０ａ、信号処理回路４０、駆動回路５０、タイミング発生回路６０ａ、同期信号発生回路７０、輝度信号検波回路８０および演算回路９０により構成されている。

【００２５】本実施形態の固体撮像装置は、図７に示す従来の固体撮像装置と較べると、固体撮像素子３０ａ、タイミング発生回路６０ａを除けば、他の構成部分はほぼ同じ回路により構成されている。ただし、本発明においては、固体撮像素子３０ａの構成および動作タイミングを工夫したことによって、電荷蓄積期間から分割された複数の期間の内、少なくとも一つの期間における露光時間を任意に設定することができ、これにより固体撮像装置における各露光期間の感度特性を自由に設定でき、高輝度領域における光量－感度特性の劣化を回避でき、ダイナミックレンジの最適化を実現した。また、改良が行われた固体撮像素子３０ａ動作タイミングを制御するため、タイミング発生回路６０ａはそれに応じた変更が行われる。

【００２６】図１に示す固体撮像装置において、同期信号発生回路７０により水平同期信号ＨＤと垂直同期信号ＶＤがそれぞれ発生される。タイミング発生回路６０ａは同期信号発生回路７０からの水平同期信号ＨＤおよび垂直同期信号ＶＤに同期して動作し、固体撮像装置全体の動作タイミングを制御する駆動パルス信号Ｓ６０ａを発生する。駆動回路５０は、タイミング発生回路６０からの駆動パルス信号Ｓ６０ａを電流／振幅増幅して、固体撮像素子３０ａに入力する。

【００２７】撮像対象物からの入射光は、対物レンズ１０および光学フィルタ２０を介して固体撮像素子３０ａに照射される。固体撮像素子３０ａは、駆動回路５０により増幅された駆動パルス信号Ｓ５０により設定したタイミングで、入射光量に応じて画像信号Ｓ３０ａを生成し、信号処理回路４０に出力する。信号処理回路４０

は、固体撮像素子３０からの画像信号を処理して、それに同期信号発生回路７０からの水平同期信号ＨＤおよび垂直同期信号ＶＤを加えた後、ビデオ信号S_{VDO}として出力する。

【００２８】輝度信号検波回路８０は、信号処理回路４０において処理途中の輝度信号Ｓ４０を受けて、それを検波し、検波信号Ｓ８０を出力する。演算回路９０は、輝度信号検波回路８０からの検波信号Ｓ８０を受けて、それに基づき画像の明るさ、コントラストや逆光状態の判定を行う。判定結果に応じて、シャッタスピード制御、対物レンズのメカアイリス制御またはＡＧＣのゲイン制御を行う制御信号Ｓ９０を発生し、対物レンズ１０、タイミング発生回路６０ａおよび信号処理回路４０にそれぞれ供給し、このフィードバックにより露光制御を行う。

【００２９】図２は本実施形態における固体撮像素子３０ａの内部構成を示す配置図である。図示のように、固体撮像素子３０ａは、マトリクス状に配置された複数、例えば、（ｍ×ｎ）個の受光素子$PD_{1,1}$，$PD_{1,2}$，…，$PD_{1,n}$，$PD_{2,1}$，$PD_{2,2}$，…，$PD_{3,1}$，$PD_{3,2}$，…，$PD_{m,1}$，$PD_{m,2}$ …，$PD_{m,n}$により構成されている受光部を有し、さらに受光部に各受光素子ごとに電荷保持素子$CR_{1,1}$，$CR_{1,2}$，…，$CR_{1,n}$，$CR_{2,1}$，$CR_{2,2}$，…，$CR_{3,1}$，$CR_{3,2}$，…，$CR_{m,1}$，$CR_{m,2}$，…，$CR_{m,n}$が設けられ、これによって本実施形態の固体撮像装置にはそれぞれの受光素子の蓄積電荷を保持する電荷保持機能が加えられた。さらに、図７に示す従来の固体撮像装置と同様に、受光部の列方向に連なって、受光素子の各列ごとに設けられている転送素子からなる垂直転送部３２、垂直転送部から送られてきた電荷を行方向に転送する転送素子からなる水平転送部３４、水平転送部の終端に設けられ、電荷の有無を検出する電荷検出アンプ３６、電荷検出アンプ３６からの信号を出力する出力アンプ３８がそれぞれ設けられている。

【００３０】受光素子$PD_{1,1}$，$PD_{1,2}$，$PD_{1,3}$，…，$PD_{1,n}$，$PD_{2,1}$，…，$PD_{3,1}$，…，$PD_{m,1}$ …，$PD_{m,n}$は、例えば、露光期間中に入射した光量に応じて所定量の電荷を蓄積するフォトダイオードなどの光センサにより構成されている。電荷保持素子$CR_{1,1}$，$CR_{1,2}$，…，$CR_{1,n}$，$CR_{2,1}$，$CR_{2,2}$，…，$CR_{3,1}$，$CR_{3,2}$，…，$CR_{m,1}$，$CR_{m,2}$，…，$CR_{m,n}$は、受光素子に蓄積した電荷を一時保持する電荷保持素子からなり、その例として、例えば、レジスタまたはキャパシタにより構成することができる。

【００３１】垂直転送部３２は、例えば、マトリクス状に配置されている受光素子の列に応じて、マトリックスの列方向に配置されているｎ列の転送素子32_{-1}，32_{-2}，…，32_{-n}により構成され、転送素子は、例えばレジスタにより構成されている。水平転送部３４は、垂直転送部からの送られてきた電荷を水平方向（受光素子がなすマトリクスの行方向）に転送する水平転送素子からなる。なお、水平転送素子は、垂直転送素子と同様に、例えば、レジスタにより構成されている。

【００３２】図３は本実施形態の固体撮像素子３０ａの動作タイミングを示す波形図、図４は固体撮像素子３０ａにおける電荷蓄積および電荷転送の動作を示す概念図である。以下、これらの図面を参照しつつ、本実施形態の固体撮像装置の電荷蓄積および転送動作について説明する。図３に示すように、本実施形態の固体撮像素子３０ａにおける電荷蓄積期間を二つの期間、即ち、露光期間Ａ１と露光期間Ｂ１とに分割されている。露光期間Ａ１と露光期間Ｂ１は、通常動作期間と垂直ブランキング期間の間に、任意に配分されている。露光期間Ａ１と露光期間Ｂ１の内、少なくとも一つの露光期間、例えば、露光期間Ａ１が図１に示す演算回路９０からの制御信号Ｓ９０に応じて設定可能であり、これにより、分割された各露光期間の入射光量－感度特性が任意に設定でき、各露光期間の間の感度比が自由に設定できる。

【００３３】以下、露光期間Ａ１、Ｂ１の順で固体撮像素子３０ａの動作を説明する。露光期間Ａ１に各受光素子に蓄積した電荷が時間T_{RO1}のタイミングで各受光素子$PD_{1,1}$，$PD_{1,2}$，…，$PD_{1,n}$，$PD_{2,1}$，$PD_{2,2}$，…，$PD_{3,1}$，$PD_{3,2}$，…，$PD_{m,1}$，$PD_{m,2}$ …，$PD_{m,n}$からそれぞれの受光素子に応じて設けられている電荷保持素子$CR_{1,1}$，$CR_{1,2}$，…，$CR_{1,n}$，$CR_{2,1}$，$CR_{2,2}$，…，$CR_{3,1}$，$CR_{3,2}$，…，$CR_{m,1}$，$CR_{m,2}$，…，$CR_{m,n}$に読み出される。なお、この読み出し動作は垂直転送レジスタ内の信号電荷に影響を与えないため、垂直転送が終了したか否かに関わらず、任意のタイミングで行うことが可能である。また、この読み出し直後に空になった受光素子は次の蓄積動作を開始する。

【００３４】図４は、固体撮像素子３０ａにおける受光素子$PD_{1,i}$，$PD_{2,i}$，…，$PD_{m,i}$からなる一行の受光素子、電荷保持素子$CR_{1,i}$，$CR_{2,i}$，…，$CR_{m,i}$からなる一行の電荷保持素子および垂直転送レジスタ30_{-i}の電荷蓄積および転送動作を図示したものである。同図（ａ）は、例として受光素子$PD_{1,i}$，$PD_{2,i}$，…，$PD_{m,i}$から電荷保持素子$CR_{1,i}$，$CR_{2,i}$，…，$CR_{m,i}$に信号電荷が転送される様子を示している。

【００３５】次に、前フィールドの信号電荷の垂直転送が終了した後、図３に示す時間T_{RO2}のタイミングで各電荷保持素子の内、奇数行の受光素子により露光期間Ａ１に蓄積した信号電荷が垂直レジスタに読み出される。図４（ｂ）に示すように、受光素子$PD_{1,i}$，$PD_{3,i}$，…などの奇数行の受光素子に対応した電荷保持素子$CR_{1,i}$，$CR_{3,i}$，…に保持されている電荷がそ

れぞれ垂直転送レジスタ３２$_{-i}$に転送される。

【００３６】次に、垂直転送部において、垂直転送を一行分行った後に、時間T_{R03}のタイミングで各電荷保持素子の内、偶数行の受光素子により露光期間Ａ１に蓄積した信号電荷が垂直レジスタに読み出される。図４（ｃ）に示すように、受光素子$PD_{2,1}$，$PD_{4,1}$，…などの偶数行の受光素子に対応した電荷保持素子$CR_{2,1}$，$CR_{4,1}$，…に保持されている電荷がそれぞれ垂直転送レジスタ３２$_{-i}$に転送される。これにより、同一露光期間Ａ１に蓄積された奇数行と偶数行の受光素子の信号電荷は垂直転送レジスタにおいて混合される。

【００３７】次に、露光期間Ｂ１に蓄積された電荷の内、奇数行に相当する受光素子の蓄積電荷が時間T_{R04}のタイミング各受光素子からそれぞれの受光素子に応じて設けられている垂直転送レジスタに読み出される。そして垂直転送部において垂直転送を一行分行った後に、時間T_{R05}のタイミングで露光期間Ｂ１に蓄積された電荷の内、偶数行に相当する受光素子の蓄積電荷が各受光素子から垂直転送レジスタに読み出される。これにより、同一露光期間Ｂ１に蓄積された奇数行と偶数行の受光素子の信号電荷は垂直転送レジスタにおいて混合される。

【００３８】図４（ｄ）に示すように、受光素子$PD_{1,1}$，$PD_{3,1}$，…などの奇数行の受光素子に蓄積した信号電荷がそれぞれ垂直転送レジスタ３２$_{-i}$に転送される。図４（ｅ）に示すように、受光素子$PD_{2,1}$，$PD_{4,1}$，…などの偶数行の受光素子に蓄積した信号電荷がそれぞれ垂直転送レジスタ３２$_{-i}$に転送され、垂直転送レジスタ３２$_{-i}$において、垂直転送で送られてきた奇数行の受光素子$PD_{1,1}$，$PD_{3,1}$，…により蓄積した信号電荷と混合される。

【００３９】以上述べた一連の動作によって垂直転送レジスタには、露光期間Ａ１に蓄積された電荷と露光期間Ｂ１に蓄積された電荷が交互に保持される。そして、読み出しが完了した後、垂直転送、垂直レジスター水平レジスタ間転送および水平転送によって、露光期間Ａ１と露光期間Ｂ１に蓄積した信号電荷は時系列に電荷検出アンプ３６に転送され、電荷検出の結果が出力アンプ３８により増幅され、画像信号Ｓ３０ａとして出力される。

【００４０】このように、露光期間Ａ１、Ｂ１のそれぞれの信号電荷は、それぞれの露光期間の違いから、入力光量に対して図５（ａ）、（ｂ）に示す光量ー感度特性が得られる。そして、固体撮像素子３０ａの後段に設けられている信号処理回路４０によってこれらの信号に対して加算／補正処理が行われ、固体撮像装置全体の特性として、図５（ｃ）に示す光量ー感度特性を得ることができる。即ち、露光期間Ａ１および露光期間Ｂ１は任意に設定できるため、図５（ａ）および（ｂ）に示すように、それぞれの露光期間に対応した感度特性の傾きを任意に制御することができる。これに応じて固体撮像装置全体の光量ー感度特性は図５（ｃ）に示すように、傾きが任意に設定でき、ダイナミックレンジの最適化制御が実現できる。

【００４１】図１に示す本実施形態の固体撮像装置において、信号処理回路４０からの輝度信号Ｓ４０は輝度信号検波回路８０において積分処理やピーク検出などの処理が施され、輝度信号検波回路８０からの検波信号Ｓ８０は演算回路９０において、画像の明るさやコントラスト、逆光状態の判定などが行われる。演算回路９０において判定された画像状態に対して、電子シャッタのスピード制御や対物レンズ１０のメカアイリス制御、またはＡＧＣのゲイン制御などを行う制御信号Ｓ９０が生成され、これを対物レンズ１０、タイミング発生回路６０ａおよび信号処理回路４０にフィードバックすることにより、それぞれの制御が撮像条件および撮像目的に応じて自動的に行われる。

【００４２】このような特徴を有する本実施形態の固体撮像装置において、検波回路８０からの検波信号Ｓ８０およびそれに基づいて演算回路９０で演算処理した結果に応じて生成した制御信号Ｓ９０によって、露光期間Ａ１と露光期間Ｂ１の感度比を任意に設定することができ、撮像状況および撮像目的などに応じて固体撮像装置のダイナミックレンジを最適化することができる。例えば、図６（ａ）に示すように画像のコントラストが小さく且つ全体に暗い状態では、露光期間Ａ１のみの露光設定としたり、同図（ｂ）のように画像のコントラストが小さいが全体に明るい状態では、露光期間Ａ１と露光期間Ｂ１の感度比を同じにするか露光期間Ａ１のみ（或いはＢ１のみ）の信号を使ったりすることが可能である。反対に同図（ｃ）に示すように画像のコントラストが大きい場合には露光期間Ａ１と露光期間Ｂ１の感度比を大きくすることで画像のダイナミックレンジを改善することができ、コントラストの度合いに応じて露光期間Ａ１および露光期間Ｂ１の感度比を変化させることも有効である。

【００４３】以上説明したように、本実施形態によれば、入射光は対物レンズ１０、光学フィルタ２０を介して固体撮像素子３０ａに照射し、固体撮像素子３０ａは露光期間を複数に分割し各期間で蓄積信号電荷に応じた画像信号Ｓ３０ａを生成し、信号処理回路４０に入力する。同期信号発生回路７０により生成した水平および垂直同期信号ＨＤ，ＶＤはタイミング発生回路６０ａおよび信号処理回路４０にそれぞれ供給し、タイミング発生回路はそれに応じた同期信号パルス信号Ｓ６０ａを生成し、駆動回路５０により増幅した後固体撮像素子３０ａに入力し、その動作タイミングを制御し、信号処理回路４０は、画像信号に同期信号を加えた複合映像信号S_{VDO}を出力する。輝度信号検波回路８０は信号処理回路４０からの輝度信号Ｓ４０を検波して検波信号Ｓ８０を出力し、演算回路９０は検波信号Ｓ８０を演算処理し、

画像の明るさ、コントラストや逆光状態を判定し、制御信号Ｓ９０を生成し、対物レンズ、タイミング発生回路６０ａおよび信号処理回路４０にフィードバックし、露光制御を行うので、撮像の状態に応じてダイナミックレンジの最適化を実現できる。

【００４４】なお、本発明は上述した実施形態により限定されるものではなく、例えば１画素当たりに複数の露光期間、即ち電荷蓄積期間を設定でき、各露光期間、または少なくともその内一つの露光期間の設定を制御できる機能を有する固体撮像装置全般に適用することができる。また、以上の説明においては、簡略化のために電荷蓄積期間は二つの期間のみに分割し、この両方の露光時間を制御する固体撮像装置およびその方法を取り上げたが、本発明はこれに限定されるものではなく、電荷蓄積期間を二つ以上の期間に分割し、それぞれの期間、または少なくとも一つの期間を制御する撮像装置に本発明を適用できることはいうまでもない。

【００４５】

【発明の効果】以上説明したように、本発明の固体撮像装置およびその方法によれば、画像状態の判定結果に応じて複数に分割された露光期間の感度比を任意に設定することで、中低輝度領域と高輝度領域の光量－感度特性のバランスを自由に設定できるため、逆光状態やコントラストの大小などの被写体の状況に応じて撮像装置のダイナミックレンジを最適化できる利点がある。

【図面の簡単な説明】

【図１】本発明に係る固体撮像装置の一実施形態を示す回路図である。

【図２】本発明における固体撮像素子の内部構成を示す配置図である。

【図３】本発明における固体撮像素子の動作タイミング＊を示す波形図である。

【図４】本発明における固体撮像素子における電荷蓄積および電荷転送の動作を示す概念図である。

【図５】本発明の固体撮像装置の光量－感度特性を示すグラフである。

【図６】被写体の明るさ、コントラストの状況を示す概念図である。

【図７】従来の固体撮像装置の一例を示すブロック図である。

【図８】従来の固体撮像素子の内部構成を示す配置図である。

【図９】従来の固体撮像素子の動作タイミングを示す波形図である。

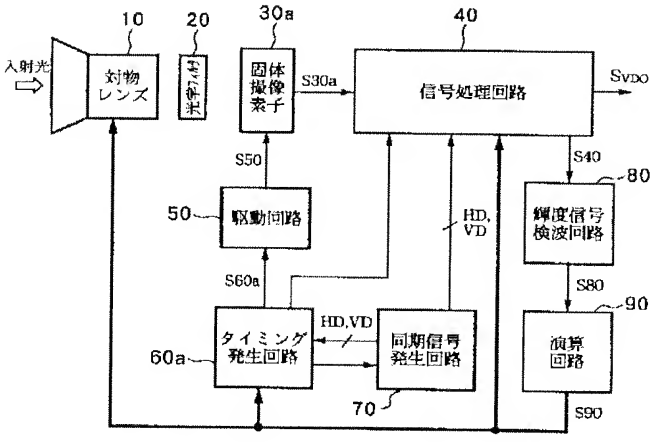
【図１０】従来の固体撮像素子における電荷蓄積および電荷転送の動作を示す概念図である。

【図１１】従来の固体撮像装置の光量－感度特性を示すグラフである。

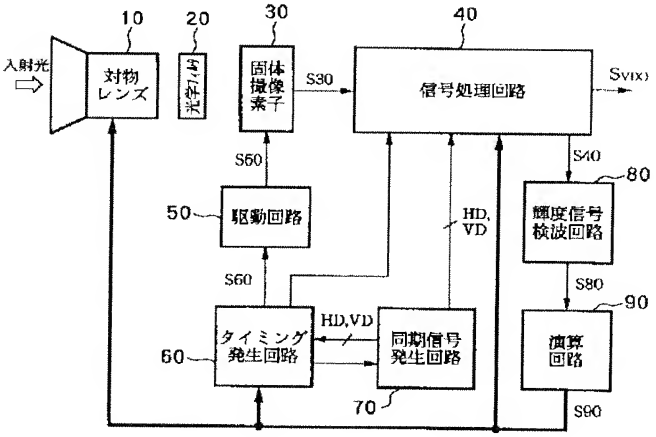
【符号の説明】

１０…対物レンズ、２０…光学フィルタ、３０，３０ａ…固体撮像素子、４０…信号処理回路、５０…駆動回路、６０，６０ａ…タイミング発生回路、７０…同期信号発生回路、８０…輝度信号検波回路、９０…演算回路、$PD_{1,1}$，$PD_{1,2}$，…，$PD_{1,n}$，$PD_{2,1}$，$PD_{2,2}$，…，$PD_{3,1}$，$PD_{3,2}$，…，$PD_{m,1}$，$PD_{m,2}$ …，$PD_{m,n}$ …受光素子、$CR_{1,1}$，$CR_{1,2}$，…，$CR_{1,n}$，$CR_{2,1}$，$CR_{2,2}$，…，$CR_{3,1}$，$CR_{3,2}$，…，$CR_{m,1}$，$CR_{m,2}$，…，$CR_{m,n}$ …電荷保持素子、３２…垂直転送部、32_{-1}，32_{-2}，…，32_{-n} …垂直転送レジスタ、３４…水平転送分、３６…電荷検出アンプ、３８…出力アンプ。

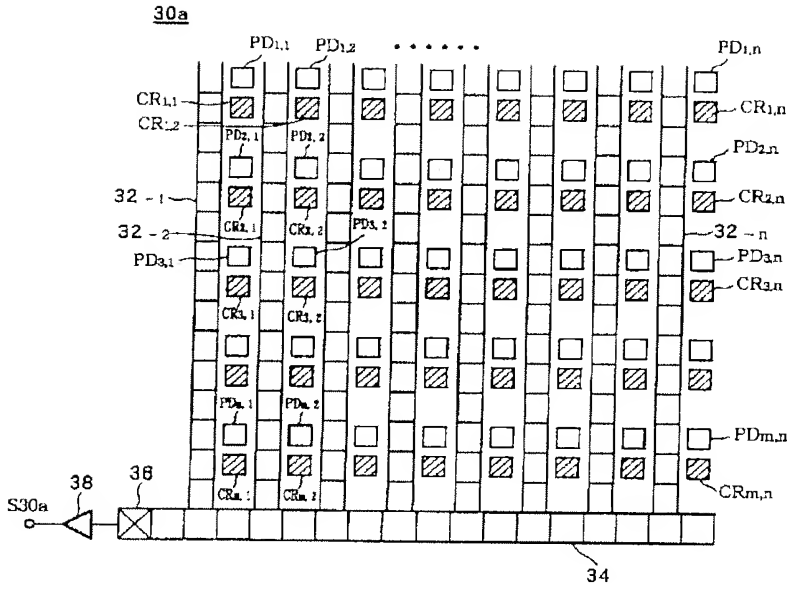
【図１】



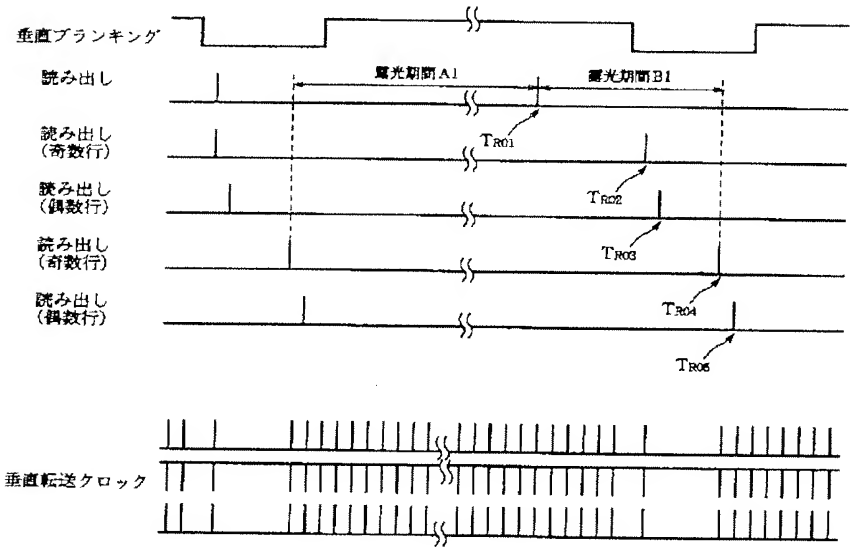
【図７】



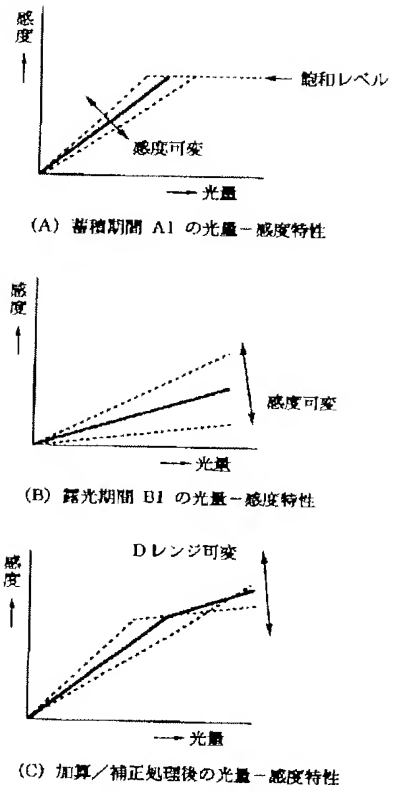
【図２】



【図３】



【図５】

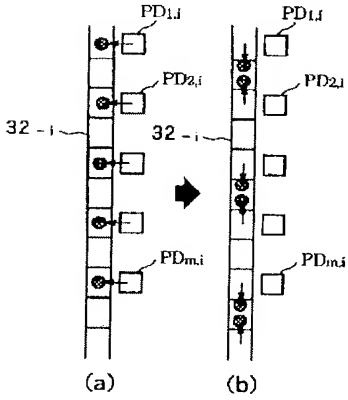


(A) 蓄積期間 A1 の光量－感度特性

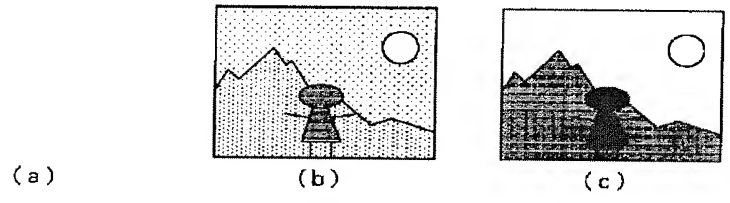
(B) 露光期間 B1 の光量－感度特性

(C) 加算／補正処理後の光量－感度特性

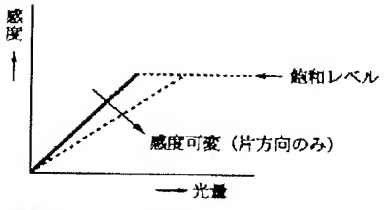
【図１０】



【図６】

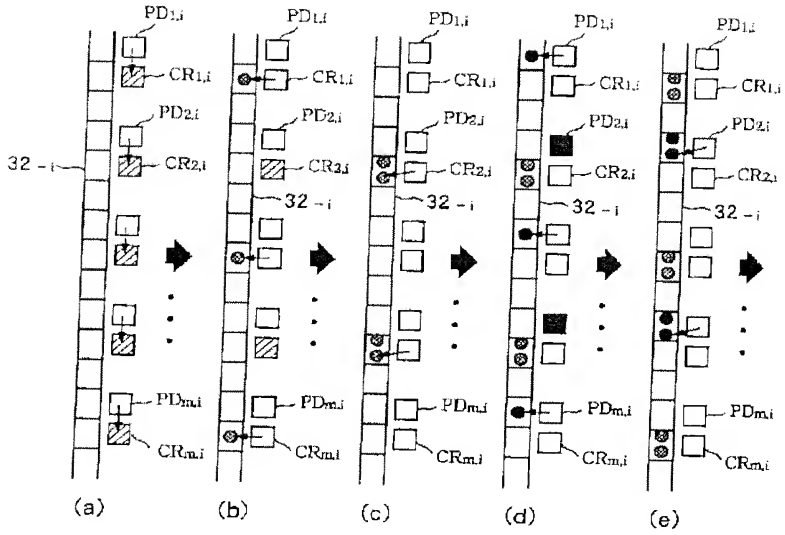


【図１１】

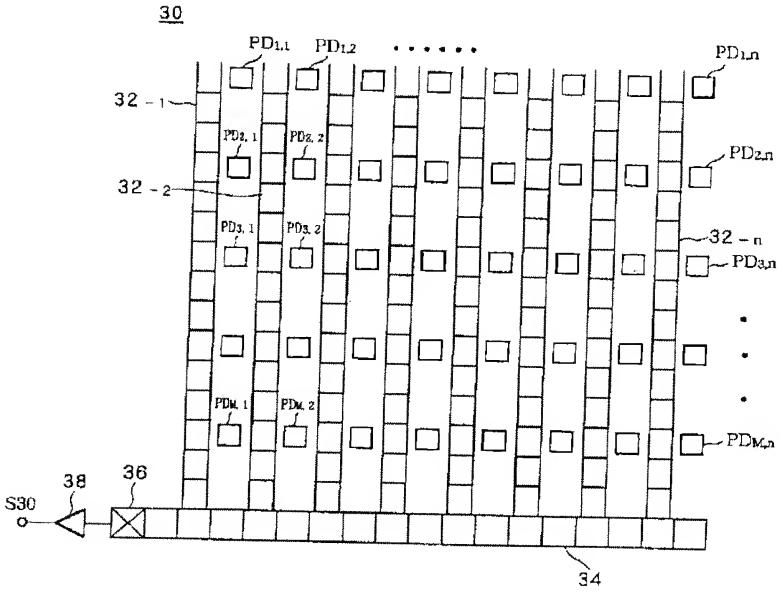


蓄積期間 A の光量－感度特性

【図４】


PD1,i
CR1,i
PD2,i
CR2,i
32－i
PDm,i
CRm,i
(a)
(b)
(c)
(d)
(e)

【図８】


30
PD1,1
PD1,2
PD1,n
32－1
PD2,n
32－2
32－n
PD3,n
PDM,n
38
36
S30
34

【図９】